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POWER AND MAGNIFICATION PROPERTIES OF CONTACT LENSES

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A number of recent publications on contact lenses¹ seem to indicate that the interest in this fascinating subject is growing.

While particular attention is naturally given to the clinical aspect of contact lenses, especially to methods of fitting them, their optical properties² are not always fully understood. It may not be in vain, therefore, to explain here in detail some important optical facts concerning contact lenses.

Since the understanding may be aided by considering the qualities of contact lenses in close analogy to the well known optical properties of spectacle glasses, a brief review of the fundamentals of ordinary ophthalmic lenses is offered for preliminary consideration.

In connection with an optical system two major questions are of concern: (a) Where is the image of a given object? (b) What is its magnification?

For a single spherical refracting surface, for instance, the front surface of a spherical cornea, the first question is answered by means of the fundamental equation

$$(1) \quad \frac{n'}{v} - \frac{n}{u} = \frac{n' - n}{r}.$$

In this formula u denotes the distance of the object; v , the distance of the image, and r , the radius of the refracting surface. All distances are measured from the vertex of the surface, the direction from left to right (the direction of light rays) being considered positive. The letters n and n' denote the indexes of refraction of the media separated by the refracting surface, n being that to the left, and n' that to the right, of the surface.

From the American Optical Company.

Read before the New England Ophthalmological Society, Nov. 16, 1937.

1. Bruce, G. M.: Contact Glasses, *Am. J. Ophth.* **20**:605, 1937. Obrig, T. E.: Fitting of Contact Lenses for Persons with Ametropia; Evolution and Modern Technic, *Arch. Ophth.* **17**:1089 (June) 1937. For additional literature on contact glasses see these two articles.

2. Hartinger, H.: Zur optischen Theorie der Haftgläser, *Ztschr. f. ophth. Optik* **18**:135-161, 1930.

LAPAL—VITAMIN D AND MYOPIA

Steiger, A.: Die Entstehung der sphärischen Refraktionen des menschlichen Auges.
Berlin, S. Karger, 1913.

Tscherning: Studien über die Aetiologie der Myopie, Arch. f. Ophth. (pt. 1)
29:201, 1883.

Vogt, A.: Parallel Between Senile and Myopic Degeneration of Eyeball, Schweiz.
med. Wchnschr. **54**:429 (May) 1924.

Ueber Berührungspunkte der senilen und der myopischen Bulbus Degeneration.
Klin. Monatsbl. f. Augenh. **72**:212, 1924.

Walker, J. P. S.: Progressive Myopia: A Suggestion Explaining Its Causation
and for Its Treatment, Brit. J. Ophth. **16**:485 (Aug.) 1932.

Wood, D. J.: Calcium Deficiency in Blood with Reference to Spring Catarrh
and Malignant Myopia, Brit. J. Ophth. **11**:224 (May) 1927.

SYNDROME OF GROENBLAD AND STRANDBERG

ANGIOID STREAKS IN THE FUNDUS OCULI, ASSOCIATED WITH PSEUDOXANTHOMA ELASTICUM

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In the course of the last fifty years various cases of angioid streaks in the ocular fundus have been reported in the literature. In all the cases the fundus showed about the same characteristic picture, consisting of a network of streaks varying in color from reddish to brownish black. As a rule, a more or less complete circular streak surrounds the optic disk at a short distance from its margin. From it mutually allied streaks take their origin; these run more radially and can be followed up to the peripheral parts of the fundus. They lie behind the retinal, and before the larger choroidal, vessels. No connection has been observed between them and one of these vascular systems. The streaks vary much in breadth, broad and narrow streaks being found together in the same fundus oculi. In general their color depends on the abundance of pigment in the fundus. In darker fundi streaks are more brownish black, whereas in lighter fundi they are more reddish brown. Locally they may be lighter, especially where larger choroidal vessels pass behind them. Not infrequently the streaks are framed by small white lines.

In most cases of angioid streaks in the fundus other extensive lesions are found, especially in the macular region. In these cases this region is occupied by a prominent grayish white mass often containing numerous irregular darkly pigmented dots on its surface, thus producing the picture described by Junius and Kuhnt as disciform macular degeneration. Smaller, nonprominent, almost round, white spots are often found in more peripheral parts of the fundus. Many authors described fresh hemorrhages in the retina in the vicinity of, or even in, the macula. In other cases no hemorrhages could be detected. The color and edges of the optic disk are mostly normal; the retinal vessels pass over the streaks without interruption. In general, both retinal and choroidal vessels show no ophthalmoscopically visible alterations, although some authors reported marked sclerosis of the ocular blood vessels. It seems,

however, questionable whether senility rather than the factors producing angioid streaks does not cause the sclerotic changes of the vessels. Certainly sclerotic changes of the ocular vessels are in no way typical of the fundic picture in cases of angioid streaks in the fundus.

Since the first description by Doyne (1889) about 140 cases of this condition have been reported in the literature. Both eyes are always involved, though the lesions are mostly not symmetrical. The cases are about equally divided between males and females (in 134 reported cases, 76 of the patients were males and 58 females). Most patients come under observation at middle age because of blurred vision, though many younger persons with this condition are seen. Bachsinjan-Frenkel in 1927 reported a case of angioid streaks in the fundus oculi in a 9 year old girl.

Histologic examination in clinically observed cases has failed for a long time to reveal the cause of the streaks. Accordingly, different hypotheses have been given to explain this interesting fundic picture. Plange in 1891 stated the belief that the angioid streaks are hemorrhages. It must be noted, however, that existing streaks are never resorbed, as often happens in the case of hemorrhages. The idea that the pigmented lines are caused by newly formed vessels was put forward by Lister in 1905. Objections to this opinion were the varying breadth of the streaks and the absence of any visible connection between them and the ocular vessels. The streaks have also been interpreted as folds of the choroid or the retina (Walser [1895]; Quist [1921]; Verhoeff [1931]). The most probable explanation was given by Kofler in 1916, who expressed the belief that the streaks are ruptures in the lamina vitrea (Bruch's membrane). At the meeting of the Dutch Ophthalmological Society in December 1936 Hagedoorn reported the results of histologic examination in a clinically observed case of angioid streaks in the fundus. The microscopic sections of the eyes demonstrated marked thickening of the lamina vitrea, which stained intensively with hematoxylin. Various fine ruptures could be seen in it, while in many places the lamina vitrea was completely absent over longer distances. In this connection it is noticeable that Behr in 1929 and 1931 demonstrated degeneration of the lamina vitrea in disciform macular degeneration, which, in his opinion, should be considered the causal factor of the changes in the macular region.

Groenblad in 1929 reported 2 cases of angioid streaks in the fundus in which the patients showed a typical lesion of the skin which was determined by Strandberg to be pseudoxanthoma elasticum. Pseudoxanthoma elasticum is a rare lesion of the skin first described by Darier in 1894 and consisting of yellowish white, somewhat papulous spots, especially on the throat and in the axillary and the inguinal region. Microscopic sections of the skin show typical changes in the elastic tissue of the middle and the deeper layer of the cutis, consisting of the

presence of numerous large lumps of elastin, while a normal elastic fibrillar structure is absent. The epidermis, the stratum papillare and the subcutis are usually not involved. I could gather 67 instances of angioid streaks in the fundus from the literature in which the skin was examined for pseudoxanthoma elasticum. In 57 cases the typical lesion of the skin was present; in 2 cases senile elastosis was found. In senile elastosis the elastic and the collagenous connective tissue of the skin are both degenerated. In 8 cases no typical lesions of the skin were found.

From this it could be concluded that in almost every case angioid streaks are the ocular manifestations of a more general disease involving probably especially the elastic connective tissue and producing pseudoxanthoma elasticum in the skin. In this connection it is also of importance that on obduction in a case of pseudoxanthoma elasticum (reported by Balzer) yellow spots were observed in the endocardium. The histologic examination showed a lesion of the elastic connective tissue similar to that present in the skin. Groenblad in 1932 discussed the possibility of similar alterations of the connective tissue in the walls of the blood vessels. Such lesions should be able to explain the tendency to hemorrhages in the fundus oculi in cases of angioid streaks. Verhoeff in 1931 reported a case of angioid streaks in the fundus combined with osteitis deformans (Paget's disease of the bones). Since then 7 cases of this combination have been published. It is noticeable that in those cases no pseudoxanthoma elasticum could be found. In connection with this it is possible that, apart from the syndrome of Groenblad and Strandberg, a second syndrome may exist in which angioid streaks in the fundus are found together with osteitis deformans but without pseudoxanthoma elasticum. A combination of both syndromes has not yet been reported.

The deeper causes of angioid streaks in the fundus have been obscure for a long time. Causal relations to any acquired disease were never found. Many authors, however, reported familial occurrence of the disease, which points to heredity as being the probable causal factor. De Schweinitz (in 1896 and 1897) saw angioid streaks in the fundus in 2 brothers. Cases of familial occurrence have since been described by Spicer (1914), Lindner (1914), Lederer (1921), Wildi (1926), Morgan and Batten (1931), Clay (1932), Hartung (1932), Sugg and Stetson (1934), Blobner (1935), Böck (1935) and Matras (1935). The first report of a more complete examination of a whole family for angioid streaks in the fundus, with remarks on the genealogic relations, was given by Hartung in 1932. He found 2 persons with angioid streaks of the fundus in one generation of 7 persons. The parents, both healthy, were blood relations. Consanguinity between the parents of

patients with angioid streaks in the fundus was also reported by Matras in 1935 and by Franceschetti and Roulet in 1936.

A case of angioid streaks in the fundus observed at the department of ophthalmology of the University of Leyden and reported in detail as follows was in many respects of special interest. In this case I had the opportunity to observe the patient for about six months, during which the development of the typical macular changes could be clinically pursued. Further, a complete examination of the whole family, comprising 26 persons divided over four generations, was made.

REPORT OF A CASE

History.—A man aged 46 years visited the outpatient department of the University Eye Hospital on Oct. 26, 1936, because of marked decrease in the vision of the left eye. The condition began fourteen days before with symptoms of metamorphopsia and photopsia. Vision of the right eye had been very poor since a blow against this eye fourteen years previously. The patient further stated that one of his elder sisters, who had lost her vision some years previously, had had identical symptoms.

Examination of the Eyes.—Vision of the right eye was 1/120; there was no improvement with glasses. Refraction showed emmetropia. Vision of the left eye was 3/10; there was no improvement with glasses, and refraction showed emmetropia. External examination of each eye and examination of the optic media showed nothing abnormal.

Fundus of the Right Eye (fig. 1 A): The almost normal optic-disk was surrounded by a broad pigmented streak, from which numerous other pigmented lines and stripes took their origin, covering the whole fundus oculi, thus producing a picture much resembling that of cracked glaze. The streaks were bordered by small white lines. In the streaks the pattern of the choroidal vessels was much more pronounced. The macular region was occupied by a prominent white mass which was covered by dark pigmented dots. The finer branches of the retinal vessels passed over the tumor. Only a single bright white spot was seen outside the macula, while the peripheral parts of the fundus were covered by numerous brown spots. The retinal and the choroidal vessels showed no alterations; hemorrhages were absent.

Fundus of the Left Eye (fig. 1 B): A network of angioid streaks similar to that found in the right eye was present in the left. The region of the macula showed a flat detachment of the retina without any tear. Some round, white spots were seen just outside the macular region. Fresh hemorrhages were absent.

Diagnosis: The condition was diagnosed as angioid streaks in each fundus oculi.

Examination of the Skin.—In the skin of the throat and of the axillary, inguinal and abdominal regions several yellow-white spots were found. Histologic examination showed typical degeneration of the elastic connective tissue of the cutis. The diagnosis was pseudoxanthoma elasticum (Dr. Dethmers).

Further Examination.—Roentgenograms of the skull, the spinal column and the pelvis showed no evidence of osteitis deformans.

The medical consultant found no signs or symptoms suggestive of any internal disease, except a slight rise of the blood pressure (160 systolic and 90 diastolic), for which no cause could be found.



Fig. 1.—*A*, fundus oculi of the right eye. *B*, fundus oculi of the left eye.

So it was evident that the patient showed the typical syndrome of Groenblad and Strandberg.

Treatment.—The patient was then treated with sodium salicylate and sodium iodide alternately, in the hope of bringing about regression of the macular detachment.

Subsequent Course.—On Jan. 21, 1937, vision of the right eye was the same as formerly. Vision of the left eye was 7/10. In spite of the improved vision, metamorphopsia and photopsia had persisted. In the macular region the flat detachment was still present, with slight irregularities in the distribution of the retinal pigment.

On February 22 the patient stated that since the last examination he had noticed decrease in the vision of the left eye, with increased photopsia. Vision of the right eye was the same as formerly. Vision of the left eye was 1/30. Ophthalmoscopic examination showed a protruding detachment of the retina in the macula. The center of the detached macula was taken up by a yellowish

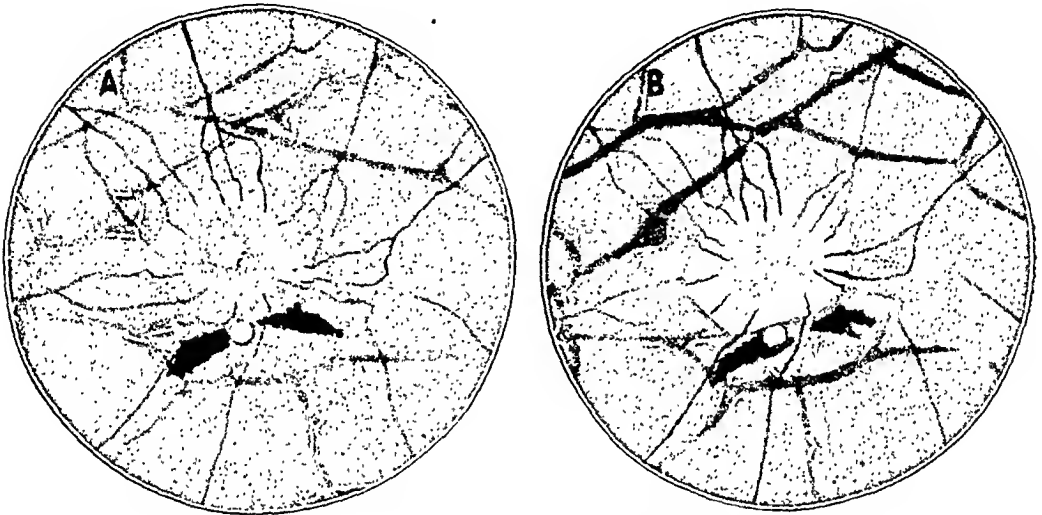


Fig. 2.—*A*, macula of the left eye, showing retinal detachment. *B*, macula of the left eye, showing prominent disk.

brown spot, which probably represented the macular pigment (fig. 2*A*). On the lower side of the macula two fresh hemorrhages were seen. The patient was admitted to the hospital to undergo a perspiration cure.

On March 19 there was no change in the vision of the right eye. Vision of the left eye was 1/24. Distinct changes had taken place in the macular region, in which a rather strongly marked, less prominent grayish disk was seen. The hemorrhages were still present (fig. 2*B*).

In this case the changes of the macular region showed the typical progression which was first described by Wildi in 1926. This author distinguished three stages in the development of the lesions in cases of angioid streaks in the fundus. In the first stage angioid streaks are found without any visible lesion of the macula and associated with normal central vision. The second stage sets in with a rather sudden decrease in visual faculty, which, according to Wildi, is due to detachment of the retina in the macular region. The detachment is caused,

in this author's opinion, by a subretinal transudate. In some cases the second stage is preceded by trauma of the eye. In the third stage the transudate is organized by connective tissue, and a pale grayish macular disk is formed.

These typical changes of the second and the third stage could be followed clearly in the left eye of the patient whose case is reported here, while in the right eye the condition had reached the third stage long before the patient was seen.

Examination of the Family.—Four generations of the family could be examined. In the first generation, only the mother of the patient was still alive. She had no angioid streaks in the fundus and no lesions of the skin as seen in pseudoxanthoma elasticum, and roentgenograms showed no signs of osteitis deformans. The father had died at the age of 63 years. Till his death some years previously he had had good vision and had been able to read small print without any diffi-

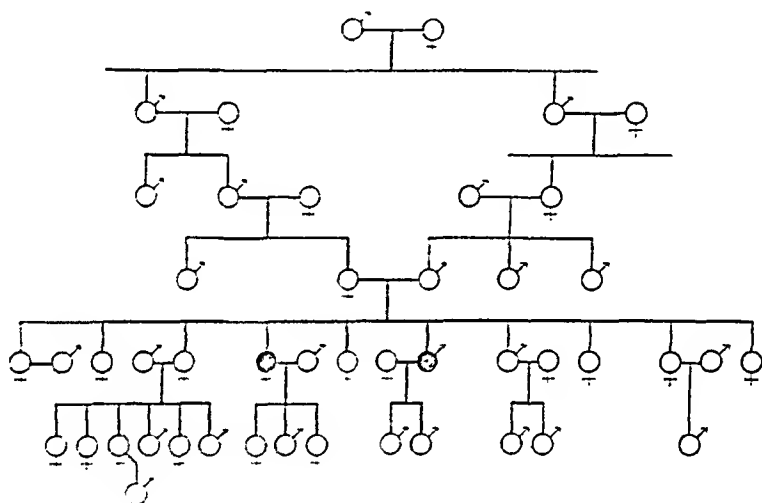


Fig. 3.—Pedigree of the patient's family.

culty, so one may believe that he also had no angioid streaks in the fundus. Further, it must be noticed that the father and the mother were cousins twice removed, as is shown by the pedigree (fig. 3).

The second generation included 10 members (2 males and 8 females). In this generation 8 persons (1 male and 7 females) were free from angioid streaks in the fundus, as was shown by ophthalmoscopic examination, and pseudoxanthoma elasticum was absent.

However, a sister of the patient showed the fully developed syndrome of Groenblad and Strandberg in the same manner as her brother. A brief report on this patient follows.

The patient, a 47 year old married woman, had vision in the right eye of 1/60; there was no improvement with glasses. Vision of the left eye was 1/10, and there was no improvement with glasses. The fundus of each eye shows numerous angioid streaks, with an extensive disciform macular lesion and disseminated white spots. Examination of the skin showed pseudoxanthoma elasticum. Roentgenograms of the skull, the vertebral column and the pelvis showed no signs of osteitis deformans.

In the third and the fourth generation, including 15 children (9 boys and 6 girls) no member showed any symptom of the disease.

As two blood-related healthy parents had among their 10 children 2 with the syndrome of Groenblad and Strandberg, while in the third generation all the members were healthy, it may be concluded, in agreement with Franceschetti and Roulet (1936), that this syndrome is due to a recessive hereditary factor.

SURGICAL TREATMENT OF LACRIMATION

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Lacrimation is an irregular symptom, sometimes very troublesome and sometimes well tolerated. Some patients are easy to cure, while others with the same history resist all treatment.

When a patient presents himself to the ophthalmologist complaining of lacrimation it is the prognosis which is most difficult to make. The lacrimation may be cured with a single probing, or it may not be relieved after several probings and a long course of treatment. Often lacrimation of several months' or years' standing yields to the first probing, while that of only a few days' duration resists prolonged treatment. Slight lacrimation may even be aggravated by the simplest and most prudent explorations.

The means of exploration, aside from irrigation and probing, such as roentgenography and rhinologic examination, seldom afford more information for the prognosis. This is due, probably, to the fact that the arrangement of the lacrimal passages allows the development of latent processes which do not manifest themselves till the moment when the obstruction is complete. Consequently obstruction without marked lesions may be produced, resulting from recent inflammation of the nasal mucosa or due to a chronic inflammatory process that has existed for years.

For best results it is advisable in cases of simple lacrimation to attempt a prudent exploration. First a few drops of cocaine hydrochloride is instilled into the eye. After a few seconds the instillation is repeated. After this one dilates the lower canaliculus slightly with a conical dilator and injects 2 or 3 drops of cocaine hydrochloride. The solution may pass into the nose, for there are cases of lacrimation without complete obstruction. If this happens it will be prudent to employ, for the moment, only irrigations with physiologic solution of sodium chloride or with very mild antiseptic solutions and to advise the patient to consult a conscientious rhinologist.

If this treatment gives no results within a few days, one attempts to pass a fine probe. But one must avoid complete probing at once, that is, passing a probe directly into the nose, for there are many cases in which the obstruction is not in the nasolacrimal duct but at the entrance or

outlet of the lacrimal sac. One begins by probing into the sac and then employs irrigation, noting if the fluid passes more easily than before the probing. If this is the case, one watches for the effect of this treatment; if the patient still complains of lacrimation, one repeats the same treatment. If, after probing into the sac, fluid still passes with difficulty, one must probe a little farther, pushing through the sac into the nasolacrimal duct without going into the nose, for the obstruction is often at this level. The probe is removed, and irrigation is again attempted. If fluid passes easily and a certain resistance has been felt at the outlet of the sac, the same treatment is repeated every three or four days until relief is obtained or for two to three weeks. If, after having passed the outlet of the sac, fluid does not pass freely, complete probing into the nose must be employed.

It is always well to add a few drops of cocaine hydrochloride to the saline solution injected, in order to obtain slight anesthesia of the lacrimal passages. Care must be taken (a precaution often neglected) to adapt the form of the probe to the anatomic position of the nasolacrimal duct and the upper border of the orbit, which varies in different persons. Probes are often too straight and at the moment of entering the duct tear the mucosa of its posterior wall. When the probe has entered the nose it is necessary that it shall exert no pressure on the upper orbital margin, for such pressure indicates that it exerts a corresponding pressure below. It must rest lightly, as if floating. Probes should have, as a rule, a curve more pronounced than is customary.

It may be supposed that fluid has not passed into the nose at the first exploration. One then proceeds with probing by progressive stages, followed by injections of a slightly anesthetic solution, made first into the sac and finally into the nose. The principle is to go no farther with the probe than is necessary. One is surprised at the frequency of obstruction at the outlet of the sac and, sometimes, at its entrance.

If, after several probings either with or without irrigation, a cure is not obtained, it is difficult to obtain one by repeated probing; it is necessary to employ other surgical methods, which will be discussed later. If, instead of simple lacrimation, there is lacrimation plus sup-puration, cure by probing is difficult to obtain. One may attempt, however, several probings and irrigations, which, while offering little chance of success, improve the lacrimation by diminishing the infection. In the great majority of cases it is necessary to employ more efficacious methods.

A separate chapter is presented by cases of congenital lacrimal obstruction in the new-born. As will be understood, complete probing employed prudently is necessary, since the obstruction is at the nasal opening of the duct.

STRICTUROTOMY

Stricturetomy, which was emphasized by Poulard, sometimes gives good results. It consists in opening widely the lower canaliculus to permit the passage of a large probe, or even of a rubber probe, which is left in place for several days. The procedure is simpler than the operations which will be described, but the results are slower and less certain. In addition, it leaves the canaliculus too widely opened.

EXTIRPATION OF THE LACRIMAL GLAND

I speak of this operation only to emphasize the fact that it has not given encouraging results in my hands. Furthermore, I have observed several cases of excessive dryness of the eye resulting from the operation. Other methods of treatment, such as obstruction of the excretory ducts of the lacrimal gland by cauterization, electrolysis of the gland or diathermic punctures, are not to be advised.

EXTIRPATION OF THE LACRIMAL SAC

This is the operation still most frequently performed for lacrimation. It has the advantage of being easy, rapid and simple. On the other hand, it leaves a definite lacrimation which is very annoying, especially to nervous and highly cultured persons. Nevertheless, there are persons who do not appreciate the value of relief from lacrimation, who are not interested in a more painstaking operation and who ask only relief from their ocular irritation. Such persons, when one proposes dacryocystorhinostomy, stating that it will relieve both suppuration and lacrimation, reply that the eye is no longer watering, although a tear may be seen on the cheek. In such cases it is not worth the trouble to perform a difficult operation of which the patient neither sees the purpose nor appreciates the advantages.

There are other cases in which extirpation of the sac should be advised. These are cases in which the patient is to undergo an operation for cataract soon after. There are ophthalmologists who consider the security against infection greater after extirpation than after dacryocystorhinostomy. For my part, I may state that I have operated for some thirty cataracts in patients who have had dacryocystorhinostomy, without the slightest infectious complication.

DACRYOSTOMY (DACRYOCYSTORHINOSTOMY)

The real progress in the treatment of lacrimation resulting from obstruction of the nasolacrimal duct is due to the operation which replaces the nasolacrimal duct by an opening through the bony wall between the lacrimal sac and the nasal cavity. Toti deserves the honor of recognition as first doing this operation. But technic and equip-

ment were not perfected so as to give a large percentage of cures. Dupuy-Dutemps and Bourget, in France, and Ohm, in Germany, have done most to perfect the technic and to increase the percentage of cures.

Toti perforated the bony wall and removed the inner wall of the sac. In the majority of cases the nasal mucosa later closed the opening made; sometimes it adhered to the mucosa of the lacrimal sac, and permeability was assured. The authors who have perfected the operation have facilitated joining of the nasal to the lacrimal mucosa by suturing the two membranes.

The operation is not simple. It is one of the most difficult in ophthalmologic practice, but the difficulties are relatively easy to conquer if one persists in following certain rules which experience has shown to be indispensable. A description of the operation follows.

Preparation of the Patient.—Little preliminary care need be given the patient. If he is very nervous it is well to give phenobarbital or barbital or even to inject morphine hydrochloride or an opium preparation. If he is a hemophiliac, for two days beforehand one gives from 2 to 3 Gm. of calcium chloride and before the operation an injection of 1 Gm. of the same drug with a similar dose of a coagulant.

Anesthesia.—Local anesthesia is nearly always sufficient. Some confrères prefer to anesthetize their patients more or less completely with rectal injections of tribromethanol in amylene hydrate or to obtain a degree of somnolence with large doses of hypnotics.

For local anesthesia a 2 to 3 per cent solution of procaine hydrochloride with epinephrine hydrochloride is employed. Three cubic centimeters of the former with from 10 to 12 drops of the latter is the best solution to use, for it is well to utilize the ischemic properties of epinephrine to a greater extent than is obtained by the solution employed by general surgeons, who inject greater quantities of the solution. From 12 to 15 drops of epinephrine hydrochloride is always well tolerated. In elderly persons and in persons with cardiovascular disease it is prudent not to give more than from 5 to 6 drops. One injects this solution with a blunt needle (for a sharp needle easily perforates the veins, which are abundant in this region) into the upper inner angle of the orbit to a depth of 2 cm. so as to reach the neighborhood of the anterior ethmoidal foramen. One cubic centimeter is injected here. The needle is withdrawn, and a few drops is injected under the skin of this region. Without being removed, the needle is passed internally to the bone, where 0.5 cc. is injected. The needle is withdrawn, and one presses the thumb on the region of the injection, moving it against the finger downward and attempting to displace a part of the injected fluid toward the inferior lacrimal region. Another puncture is made in this region toward the angle formed by the inferior and inner walls of the orbit, where 1 cc. of solution is injected. The needle is with-

drawn, and pressure is made over this region. On the side of the nasal mucosa anesthesia is obtained by equal parts of a 4 to 5 per cent solution of cocaine hydrochloride and a 1:1,000 solution of epinephrine hydrochloride. This may be applied with an atomizer or by cotton pledgets attached to a thread from 10 to 15 cm. long, which are placed in that portion of the nasal region corresponding to the lacrimal sac. The threads are left hanging from the nostril so that the pledgets may be easily withdrawn. During anesthetization of the nasal mucosa the patient remains seated, with the head held forward so that the solution does not enter the throat.

Anesthesia is immediate, and the operation may be begun at once.

Incision.—This is made as for extirpation of the sac, that is to say, from 2 to 3 cm. from the inner angle of the eye and from 2 to 3 cm. long. One seeks the internal canthal ligament, which is dissected to its bony attachment, which is later detached from the bone with the rasp. The speculum of Müller with pointed hooks is put in place, and the sac, which is always behind the ligament, is separated from the bone. If certain vessels bleed excessively one attempts to catch them with the hooks of the speculum. The tampons are withdrawn from the nose.

Perforation of the Bone.—For this procedure one of two methods may be employed. One may use a mallet and chisel or a trephine and bur. The first method is easier, but slower and more disagreeable for both the patient and the physician.

If one employs a mallet and chisel, one begins by removing the lacrimal crest, for it is here that the bone is thickest. The thickness of the bone varies greatly in different persons, and one must be very careful not to wound the nasal mucosa. At the site of the unguis one must count on extreme thinness of bone and often on the presence of ethmoid cells. The bony opening must be large, about 1.5 cm. in diameter. When the nasal mucosa is well exposed in the opening, the operation is continued as will be described.

If perforation with the trephine is employed, one must use a trephine with a center pin to prevent slipping (fig. 1). When this trephine has been applied for ten to fifteen seconds, it is replaced by one without a center pin, which is applied in the groove made by the first trephine. During the trephining it is necessary to protect the sac by a bent spatula. One must lean with the hand holding the trephine on the patient's head. In this way when perforation of the bone occurs one will not enter the nasal cavity abruptly. It is prudent to test, from time to time, with a small elevator, the mobility of the osseous disk to avoid wounding the nasal mucosa and to determine the point where perforation first occurs. Sometimes one sees in the depth of the furrow a little blood coming from the mucosa, which indicates the necessity of raising the bony disk with the elevator and of not continuing with the trephining,

for in many cases one does not reach the mucosa in the whole extent of the furrow at the same time. The thickness of the bone being variable, one of the sides may be perforated while on the other side there remains a layer to trephine. But with the elevator the part not perforated breaks easily.

One may enter completely or partially into ethmoid cells. In this case one separates the lamellae forming the walls of these cells with a sturdy forceps having broad points. This may also be done with the spatula used to protect the sac. In any case, one must try to expose the mucosa without wounding it. To determine whether one has

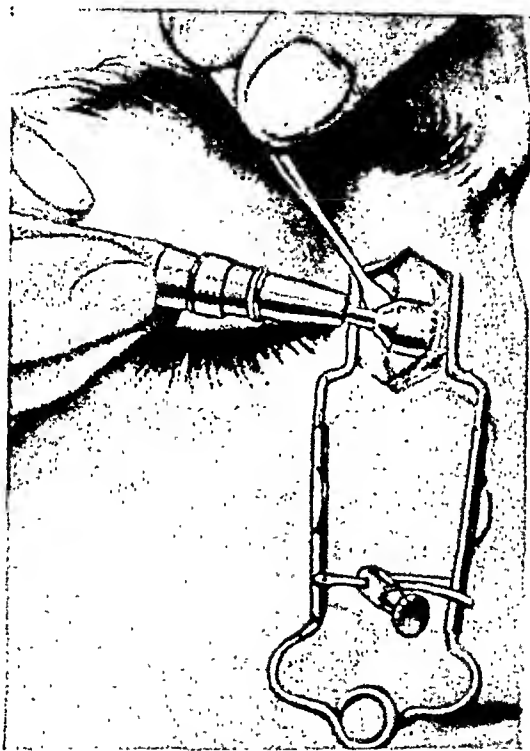


Fig. 1.—Opening in bone being made by trephine.

reached the mucosa of the nasal cavity one may introduce an instrument into the nose, directed toward the field of operation.

At this moment it is necessary to enlarge the bony opening, which may be done with a cylindric or spherical bur. A convenient instrument for this purpose is the bur of Gutzeit. This permits enlargement of the opening, while the mucosa is protected.

It is of advantage that this enlargement of the opening be made especially on the nasal side, by beveling the bony opening; thus the opening will have a conical form, and the mucosa will approach the sac at an obtuse angle instead of a right angle. This favors also the movement of the mucosa toward the sac in parts of the opening which are not covered by sutured mucosa.

If in perforating the bone one has wounded the mucosa, it is sometimes impossible to make the sutures which will be described. One must adapt one's procedure to the lesion produced. If the mucosa in the anterior part is wounded, a posterior suture is made with the flap of the mucosa existing, and one tries to obtain an anterior flap by enlarging the bony opening anteriorly. If, on the contrary, the mucosa in the posterior part is wounded, one does the same, procuring a posterior flap. If the mucosa is sectioned in its entire circumference, one must content oneself with freeing, as well as possible, the flaps of mucosa by enlarging the bony opening. In any case, it is necessary to make a beveling as large and as perfect as possible.

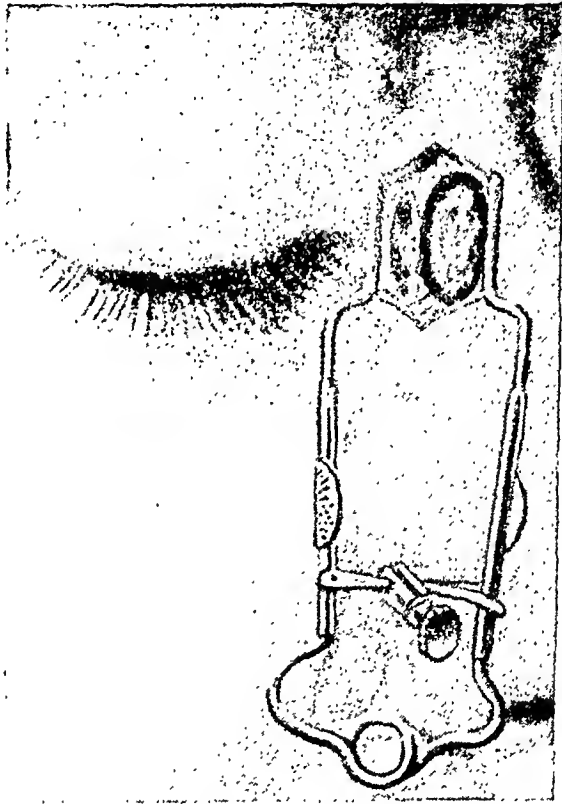


Fig. 2.—Opening enlarged by bur; incision in lacrimal sac.

When a flap of mucosa barely suffices to reach the flap of the sac, one may make an incision in the peripheral part of the flap at the level of the bony margin. In this way the central part of the flap may reach the sac, which facilitates making the sutures. The flap thus cut at its base forms a bridge, but this has no disadvantage.

Opening of the Lacrimal Sac and Nasal Mucosa.—When the nasal mucosa is ready and free along the whole length of the bony opening, the lacrimal sac is cut vertically; sometimes it is useful to introduce a probe through the inferior canaliculus in order to be sure of one's position. Then the posterior flap is grasped with a forceps and drawn

toward the nasal mucosa. At the place where these two membranes touch an incision is made in the nasal mucosa, in the same direction as, and parallel to, the incision of the sac, reaching to the edges of the bony opening (fig. 2).

Suture of the Mucous Membranes.—One now has two posterior and two anterior flaps, one belonging to the sac and one to the nasal mucosa in each region. For the sutures one may employ a needle of Deschamps, or needles that are smaller but of the same type, such as have been devised by various confrères. I use very small curved needles in a needle holder with a curved and delicate tip, with which I reach

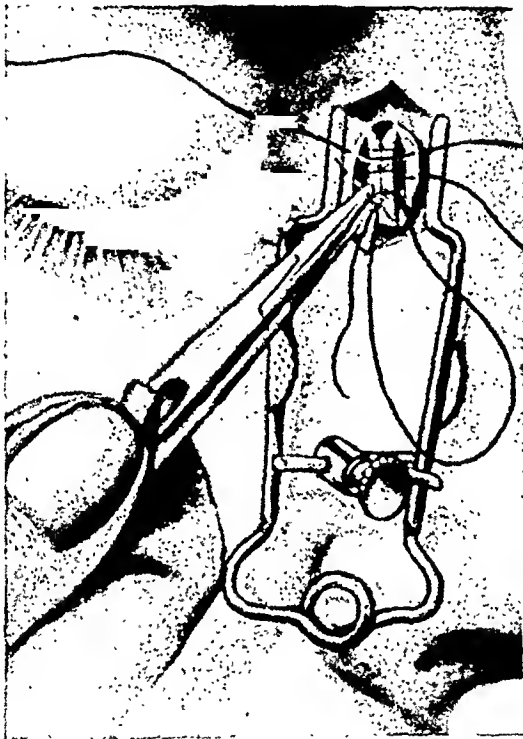


Fig. 3.—Suture of lacrimal sac and nasal mucosa; posterior sutures tied; anterior sutures being placed.

easily the deeper structures. Silk is preferable to catgut for the sutures. I employ no. 0 or no. 00 silk.

One must naturally begin with the posterior sutures, following these with the anterior ones. One may usually place three sutures in each region. If the sac is very small it is necessary to be content with two, while when it is very large four sutures may be placed on each side. It is necessary to remove the speculum before tying the anterior sutures (figs. 3 and 4).

Suture of the Skin.—The external suture may be made by the customary methods. I employ a continuous suture, for with this there

is no tendency of the borders of the wound to gap. It is only necessary to take care that approximation of the edges is exact (fig. 5).

Dressing.—It is well to apply an ointment to the region of the operation so that the dressing will not stick to it. Light pressure on the region is also favorable. The dressing is applied, as is customary, with a bandage, in order to exert pressure on the region, which is obtained with adhesive tape. Attention must be paid that the eye remains well closed. A little cotton is placed in the nostril on the side on which the operation has been performed, which is retained for the remainder of the day. It may be necessary to change this from time to time. During

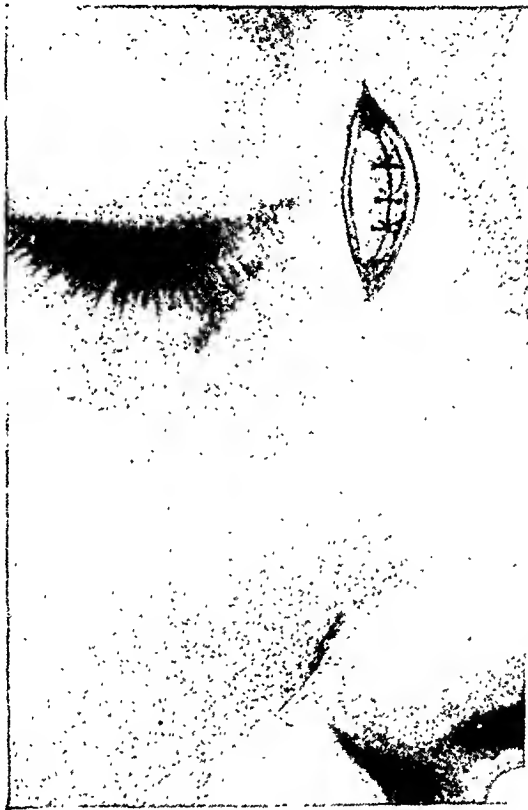


Fig. 4.—Sutures completed.

sleep it may be removed, and on the following days there is no need of it, unless the nose bleeds, which is seldom the case. It is rare that a copious hemorrhage occurs. In case it does, gauze soaked in petrolatum is packed in the region of the nose in which operation has been performed. Or one may employ small cotton tampons attached to a thread which passes out of the nostril, the pledgets being soaked in oil so they will not adhere to the region of the operation. Hemorrhage stops at once, for the bleeding area is compressed by the gauze or cotton which is held between the septum and the operative field. One may, especially if the patient is a hemophiliac, take general precautions, using calcium chloride and coagulating agents.

After two days one removes the tampon, and generally there is no more bleeding. If it does occur, the application of tampons must be prolonged, but this is rarely required.

Postoperative Treatment.—It is not necessary that patients be hospitalized for this operation, but the dressing must be changed daily. Prudent irrigations of the sac are favorable. One should not inject antiseptic solutions which may infiltrate the tissues and provoke troublesome edema. It is best to employ physiologic solution of sodium chloride. The second dressing need not exert pressure like the first. One repeats the treatment for several days. On the fourth day the

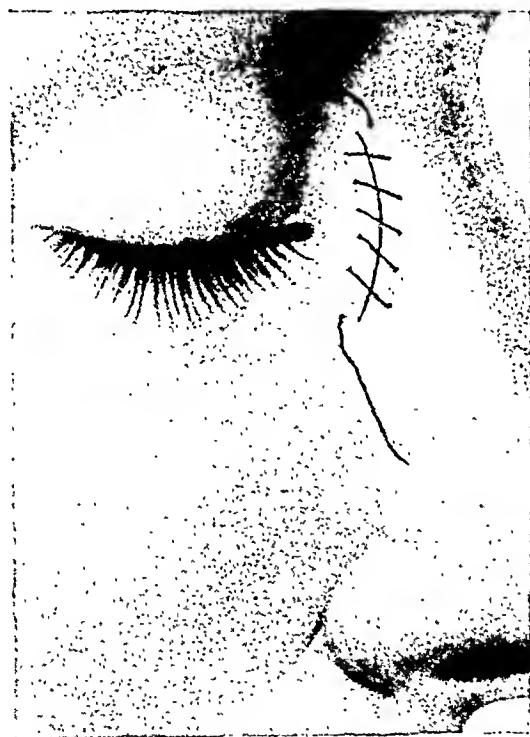


Fig. 5.—Skin closed by running untied suture.

cutaneous suture is removed, and no dressing is employed. The patient is advised against blowing the nose strongly, which may result in emphysema of the region of the operation. If during the treatment it is noted that fluid injected through the canaliculus does not escape into the nose, prudent probing is employed, the probe being passed directly toward the bony opening and an attempt being made to find the opening in the mucosa and to free it by movements of the probe.

Results.—In almost all cases the result is favorable, especially if one has been careful not to wound the sac or the nasal mucosa, if a large bony opening has been made and if the sutures have been correctly placed. Even the presence of ozena constitutes no contraindication.

All operators have had favorable results in cases in which there were marked changes in the nasal mucosa. The percentage of cures is more than 95.

Recurrence.—In certain cases an obstruction of the opening may occur during the first few weeks or months after the operation, rarely after two or three months. In such cases it is necessary to perforate the membrane which closes the opening. For this purpose one anesthetizes the nasal mucosa as for the aforescribed operation and injects cocaine hydrochloride and epinephrine hydrochloride into the sac. The lower canaliculus is dilated with probes of increasing size. When a no. 5 or no. 6 probe passes, one leaves it in place for several minutes. Then a Weber knife is passed by the same route, being introduced with a little force through the membrane, and an incision from above downward is made to form a buttonhole in the membrane. One may also

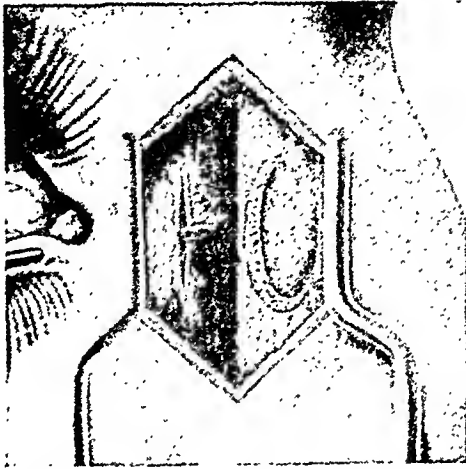


Fig. 6.—Operation when lacrimal sac has been removed; incision in wall of canaliculus, showing probe.

open the membrane transversely. The knife is withdrawn carefully, with the back resting on the wall of the canaliculus. In most cases lacrimation stops after this operation, for the buttonhole produced in the membrane suffices for drainage. This is favored by the tendency of cicatricial tissue to retract.

OPERATION IN CASES OF ABSENCE OF THE LACRIMAL SAC

In cases in which the lacrimal sac has been removed it is possible to obtain reestablishment of lacrimal drainage into the nose by dacryostomy. It is surprising that such a result can be obtained when there is no sac which may be sutured to the nasal mucosa, but the facts show that it is possible. If the lower canaliculus is in good condition in its whole length the operation is a success in two thirds, or even three fourths, of the cases. Integrity of the inferior canaliculus is indispensa-

ble for the operation. Bone that is not too thick and ethmoid cells that are not too large are favorable, since thick bone and large ethmoid cells separate the nasal mucosa from the end of the canaliculus greatly.

The technic of this operation does not differ greatly from that already described. I shall mention only its special points.

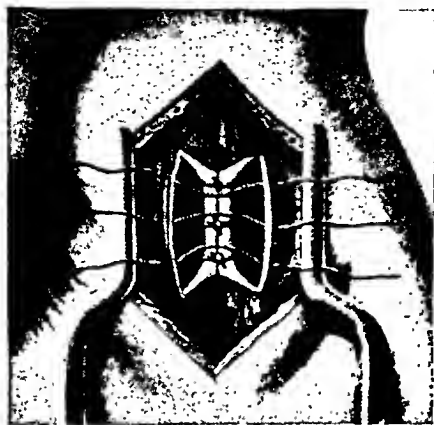


Fig. 7.—Sutures between canaliculus and nasal mucosa.

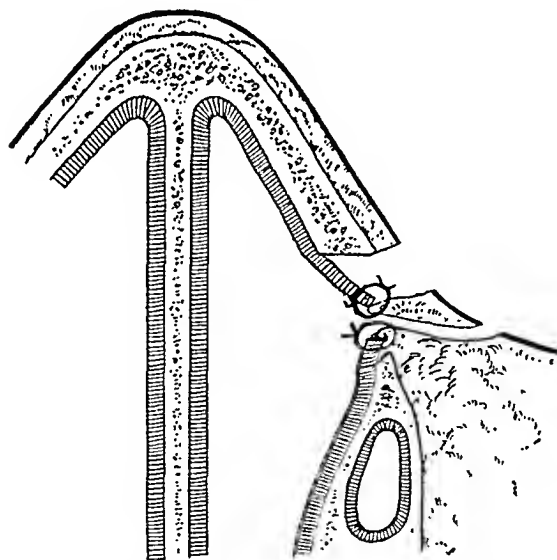


Fig. 8.—Diagram of sutures.

Incision of the Skin.—This is made in the customary place, but, as there is no sac, one finds in its place only scar tissue. This is traversed by the incision close to the bone as far as the posterior lacrimal crest or the posterior part of the lacrimal fossa.

Perforation of the Bone.—This is performed as already described. One must not fail to make the opening large, for in this case one must go far to reach the nasal mucosa, and the larger the opening the easier it is to make it reach the canaliculus.

Procuring the External Flaps.—A probe is passed through the inferior canaliculus. Its point makes a prominence in the scar tissue. Maintaining this prominence by pressure with the probe, one cuts the tissue over the point of the probe vertically until the probe appears. The incision is prolonged inward and downward deeply into the scar tissue. A wound is thus obtained formed by two lips or flaps, an anterior and a posterior flap (fig. 6).

Opening of the Nasal Mucosa.—An incision is made in the customary direction but at a point which corresponds as nearly as possible to the incision which has been made on the external wall of the wound.

Suture.—Posterior and anterior sutures are placed as in the classic dacryocystorhinostomy. The posterior sutures unite the posterior flap of mucosa and the posterior lip of the wound previously made. The anterior sutures unite the anterior flap of mucosa with the anterior edge of this wound. Before the latter sutures are tied the speculum is removed (figs. 7 and 8).

Suture of the skin is made as already described.

Postoperative Treatment.—Daily irrigation after previous probing is performed. In general, no difficulties occur. If obstructions of the opening develop, probing may always be attempted and is, as a rule, simple.

GALACTOSE CATARACT IN RATS

FACTORS INFLUENCING PROGRESSIVE AND REGRESSIVE CHANGES

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The observation that galactose is unique as an etiologic factor in the production of experimental cataract in rats was first reported by Mitchell¹ and later confirmed by Yudkin² and Day.³ The earlier work with lactose and other sugars⁴ led to the realization that it was probably the galactose fraction of the lactose molecule which caused the injury. Galactose has supplanted lactose for the production of most of the experimental cataracts in the laboratory of the Massachusetts Agricultural Experiment Station because of the more rapid and consistent results obtained. Whichever sugar is used, however, it is logical to speak of galactose cataract in contrast to the vitamin G deficiency cataract. Both may well be designated as nutritional cataracts.

The fact that the rat is susceptible to lenticular changes as a result of vitamin G deficiency or of intolerance for galactose makes it a valuable experimental animal for further study of dietary factors influencing the transparency of the lens. Whether these experimental cataracts are analogous to any recognized clinical types has not been determined but the possibility of experimental production of opacities of the lens under carefully controlled conditions permits a new approach to a baffling subject.

The discovery that a specific carbohydrate intolerance could cause opacities of the lens in young rats led to the use of this experimental device for studying the nature of cataractous changes from several

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1. Mitchell, H. S.: Cataract in Rats Fed on Galactose, *J. Nutrition* (supp.) **9:14** (June) 1935; *Proc. Soc. Exper. Biol. & Med.* **32:971**, 1935.

2. Yudkin, A. M., and Arnold, C. H.: Cataract Formation in Rats Fed on a Diet Containing Galactose, *Proc. Soc. Exper. Biol. & Med.* **32:836**, 1935; Cataracts Produced in Albino Rats on a Ration Containing a High Proportion of Lactose or Galactose, *Arch. Ophth.* **14:960** (Dec.) 1935.

3. Day, P. L.: Blood Sugar in Rats Rendered Cataractous by Dietary Procedures, *J. Nutrition* **12:395**, 1936.

4. Mitchell, H. S., and Dodge, W. M.: Cataract in Rats Fed on High Lactose Rations, *J. Nutrition* **9:37**, 1935.

angles. Galactose cataract develops most readily in young rats, while adult animals show more resistance to lenticular changes due to a foreign sugar in the blood. This may indicate that the young lens is more easily injured than the old one by chemical changes in the surrounding medium. Certainly the young lens appears to be more susceptible to injury from galactose than other tissues in the body, so far as has been observed. Other than changes in the sugar contents of the blood and urine, no pathologic condition has been evident in these animals, either while they were alive or at autopsy. The conjunctivitis and alopecia which may accompany vitamin G deficiency cataract are entirely absent in these animals. In fact, growth has been normal in all rats fed galactose at various levels (15, 25 and 35 per cent) supplemented with starch in an otherwise adequate ration. Lactose at high levels usually causes diarrhea and some retardation of growth. The experience of Clapp⁵ that rats on galactose and lactose rations died before opacities developed is difficult to explain unless the rations were inadequate in some other respect.

SUSCEPTIBILITY OF STRAINS

A variation in the susceptibility of different breeds or strains of rats to galactose cataract⁶ and a lesser but nevertheless significant difference between litters are observations which have proved to be of increasing importance in the study and interpretation of accumulated data. Variation in strain must be considered in comparing the results from different laboratories. Variation in susceptibility between litters emphasizes the necessity for carefully controlled experiments with litter mates and the use of several litters of rats when the influence of dietary factors is being observed. The failure of Bellows⁷ to use litter mates in making his comparisons materially lessens the significance of his findings.

While the factor of heredity is of interest and importance in interpreting the results of experiments, it does not overshadow the nutritional problem. There is no evidence that even the more susceptible strains of this species (the white rat) show any tendency to the spontaneous development of cataract. During the last fifteen years over six thousand rats from a colony maintained on various types of

5. Clapp, C. A., in discussion on Tassman, I. S.: *Experimental and Clinical Studies of Cataract*, Arch. Ophth. **17**:948 (May) 1937.

6. Mitchell, H. S.: *Susceptibility of Different Strains of Rats to Nutritional Cataract*, J. Nutrition **12**:447, 1936.

7. Bellows, J. G.: *Biochemistry of the Lens: IX. Influence of Vitamin C and Sulfhydryls on the Production of Galactose Cataract*, Arch. Ophth. **16**:762 (Nov.) 1936.

adequate and inadequate diets have never shown visible injury to the lens except on lactose or galactose rations.

STUDIES OF THE SUGAR CONTENTS OF THE BLOOD AND URINE

Determinations of the sugar contents of the blood and urine⁸ were made on several series of rats fed rations containing 62 and 70 per cent lactose, 25 and 35 per cent galactose, 35 per cent fructose, 35 per cent xylose and 70 per cent starch. The values for the total blood sugar content were higher for the rats on galactose diets than for those on lactose diets but were above normal for all the animals on cataract-producing rations—in contrast to the normal levels observed with all other carbohydrates. The nonfermentable fraction of the blood sugar (galactose) varied with the amount of lactose or galactose fed, but the fermentable fraction (dextrose) remained nearly constant and within the range of the normal blood sugar content. Galactose was observed in varying amounts in the urine of all the rats on lactose and galactose rations; the content was relatively higher in the urine of the animals fed galactose, and the sugar was absent in the urine of starch-fed control rats. It was concluded that galactose is the sugar responsible for the high sugar contents of the blood and urine of rats fed lactose or galactose rations and must be the major etiologic factor in galactose cataract.

INFLUENCE OF PROTEIN FACTORS IN THE RATION

The ration containing 25 per cent galactose, used in most of our studies,⁹ contained 15 per cent protein (casein), 70 per cent carbohydrate (starch and galactose), 11 per cent fat (hydrogenated cotton seed oil and cod liver oil) and 4 per cent salt mixture (Osborne and Mendel). Reduction of the protein content from the regular 15 per cent level to the 5 per cent level shortened the time of the development of cataract from twenty-six to fifteen days, a difference which is strikingly significant. Earlier attempts to alter the speed of lenticular changes by increasing the amount or altering the type of protein yielded negative results, but more recently high protein rations have tended to delay the development of cataract.

Bellows' observation of an inhibitory effect of 0.3 per cent cystine added to a ration containing 35 per cent galactose could not be confirmed. Subsequently larger amounts of cystine (1, 2 and 3 per cent) added to a ration containing 25 per cent galactose did have a slight inhibitory effect. This twenty-fold increase in cystine over the amount

8. Mitchell, H. S.; Merriam, O. A., and Cook, G. M.: The Relation of Ingested Carbohydrate to the Type and Amount of Blood and Urine Sugar and to the Incidence of Cataract in Rats, *J. Nutrition* **13**:501, 1937.

9. Mitchell, H. S., and Cook, G. M.: The Influence of Protein and Cystine Intake on the Cataract-Producing Action of Galactose, *Proc. Soc. Exper. Biol. & Med.* **36**:806, 1937.

present in the usual ration had such a minor inhibitory action as to raise the question whether the cystine content of the ration is really a crucial factor in spite of the loss of cysteine in a cataractous lens. Other protein factors are being investigated.

ALTERATION OF OTHER FACTORS IN THE RATION

Clinical experience and chemical analyses of lenses have suggested various factors which might exert an influence on the production of cataract. Various types of supplementary carbohydrates (starch, dextrin, sucrose and dextrose) used with galactose have been tried, without alteration of the speed or incidence of cataractous changes.

The type of fat (hydrogenated cotton seed oil, butter, mutton tallow, cod liver oil) and the amount (2, 11, 22 and 46 per cent) were varied systematically in galactose rations, without appreciable alteration in the production of cataract. An apparent delay with high fat rations fed ad libitum proved to be due to the difference in the amount of galactose actually consumed. A more detailed report on this phase of the work will be published elsewhere.

The cataract-producing action of lactose or galactose was not modified or altered by a variety of other supplements to or modifications of the ration,¹⁰ such as: (1) addition of excess cholesterol (2.5 and 5 per cent), (2) shifting of the acid-base balance (4.76 per cent sodium citrate or 3.4 per cent ammonium chloride), (3) regulation of the amount of water ingested, (4) administration of cevitic acid orally or injected, (5) deficiency or excess of vitamin B₁ or vitamin B₂, (6) ingestion of large doses of dinitrophenol and (7) administration of protamine insulin.⁸

STAGES OF DEVELOPMENT AND REGRESSION OF CATARACT

1. *Early Lenticular Changes*.—During the past two years all the rats on cataract-producing rations have been examined weekly or semi-weekly with an ophthalmoscope for early lenticular changes. In white rats there is so little pigment in the iris that gross changes may be observed through this tissue, but it is far more satisfactory to dilate the pupil. A drop of a 0.2 per cent solution of atropine sulfate administered from twenty to thirty minutes before the examination has been adopted as a satisfactory routine.

In previous attempts to describe these early lenticular changes the investigators failed to follow the sequence of stages accurately, or mention of certain changes were omitted altogether. The frequent

10. Mitchell, H. S.; Cook, G. M., and Merriam, O. A.: The Specificity of Galactose as a Cataract Producing Agent. *J. Nutrition* (supp.) **13**:18 (June) 1937.

examination of over sixteen hundred eyes by one person has disclosed certain differences between rapidly and slowly developing cataract which warrant more detailed description.

Rats fed galactose show early and rapid lenticular changes varying in proportion to the amount of this sugar ingested or to other relevant factors. The more slowly developing cataracts in rats fed lactose showed fewer of the early changes consistently observed in the galactose-fed animals. In eyes with the rapidly developing type of cataract, as early as the fifth day a narrow, dense shadow is evident in the equatorial region of the anterior cortex. This dense film appears to have a cell-like structure and increases rapidly in extent until the eighth to the twelfth day, when it may cover from one half to seven eighths of the anterior surface of the lens. Slit lamp observations by two ophthalmologists have confirmed our observations.¹¹ This phenomenon is undoubtedly similar to that recently described by Bellows⁷ as a "dark

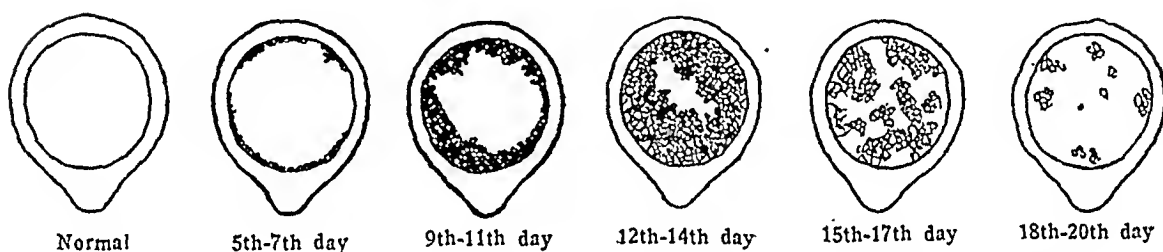


Fig. 1.—Diagram of early changes in the cortex of the lens preceding the development of actual opacities. The sequence is characteristic of a rat on a ration containing 25 per cent galactose. Note the increasing area involved in the first three stages and the scattered transparent masses in the later stages.

reflex with the ophthalmoscope" or a "peripheral opacity" which later became "confluent and extended centrally." All this applies to what we have observed, except that the film seldom covers the entire cortex, and instead of becoming more dense to the point of complete opacity, as Bellows inferred, it has been invariably observed that it becomes less dense after the twelfth to the fourteenth day and later appears as transparent vacuoles scattered singly or in masses over any part of the anterior cortex. The drawings in figure 1 illustrate five stages of this progressive change as seen ophthalmoscopically, showing the increasing area involved in the first three stages and the scattered transparent masses in the final stages. The thinning out and scattering allow observation of the deeper lenticular changes. In the posterior cortex and deeper in the lens substance spokelike or irregular opacities develop

11. Dr. Frank E. Dow, of Northampton, Mass., and Dr. Theodore L. Terry, of the Massachusetts Eye and Ear Infirmary, Boston, have generously cooperated in examinations of the eyes and have read the manuscript of this paper.

rapidly to the point where a dense white nucleus is visible to the naked eye. In almost every case the anterior vacuolated film has disappeared before the true cataract is visible. This early change in the anterior cortex is somewhat commensurate with the degree of injury to the lens as measured by the time required for mature cataract to develop, but it is not considered a sufficiently accurate criterion for comparing the specific effect of various dietary factors. In many cases of slowly developing cataract in lactose-fed rats the early change is absent or inconspicuous. Radial lines deep in the lens may be the first change observed.

2. *Visible Opacity of the Lens.*—The first well defined opacity visible to the naked eye is a posterior opacity, which is usually observed from one to three days before a dense nuclear opacity is

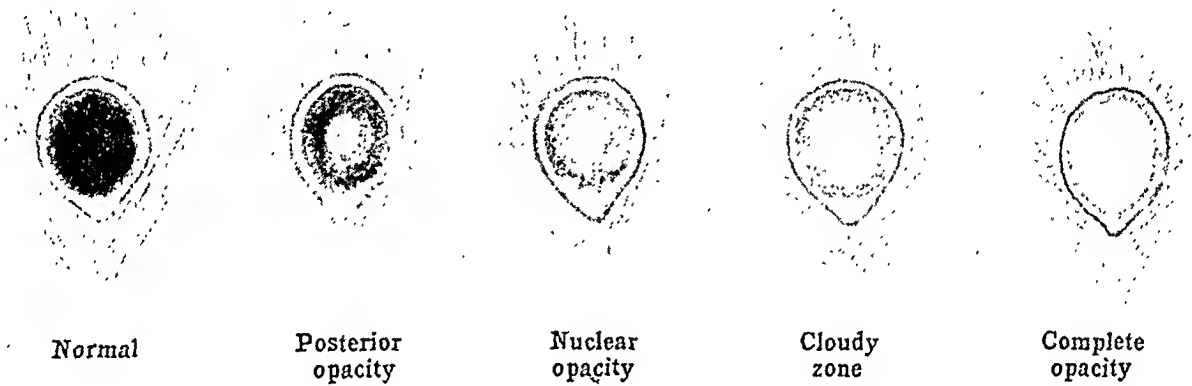


Fig. 2.—Development of visible opacities in a rat fed a galactose ration. The faint posterior opacity changes to dense white in two days or less; then gradually a cloudy zone develops until the entire lens is completely opaque from ten to twelve days later.

seen. If observations are not made daily the stage of the posterior opacity is easily missed. In earlier work the rapidity of these changes was not fully appreciated, and some of the earliest visible opacities were not recorded. The stage of nuclear opacity usually lasts from eight to twelve days, progressing gradually, with the development of a more peripheral cloudy zone, to what has been designated by us as the stage of complete opacity, when the entire lens appears dense white to the naked eye. Four degrees of developing opacity are shown in figure 2, together with the artist's concept of the normal appearance of the lens. This arbitrary division into several degrees of visible cataractous stages has been adopted to facilitate recording of progressive changes. The terms used may not conform exactly to those used in clinical practice but are descriptive of visible changes rather than histologic ones.

A study has been made of our accumulated data to determine the time of the first appearance of the opacity and the duration of the three stages, that of posterior, that of nuclear, and that of complete, opacity. It was surprising to discover that in spite of rather striking differences in the time of the first appearance of the posterior opacity, the change through the nuclear stage to that of complete opacity proceeded at a remarkably uniform rate, regardless of dietary changes.

It might be anticipated that when the aggravating factor (galactose) was omitted from the ration the progress of the cataractous change would be inhibited or stopped altogether. For the majority of the animals the galactose ration was discontinued, because of its expense, as soon as the stage of dense nuclear opacity was reached. In all but a few instances the lenticular changes progressed to complete opacity, regardless of this shift to a "normal" diet. There was apparently a lag in the effect of galactose or else a physiologic sequence of events which, once started, could not be altered. Those rats retained on lactose or galactose rations until after complete opacity had developed were, in general, the more susceptible animals of a litter. The slightly more rapid development of complete opacity in these animals than in those changed to the stock ration at the stage of dense nuclear opacity may have been due to prolongation of the aggravating factor (galactose) in the ration or to greater susceptibility to the lenticular changes. This inevitable progress of the opacity to involve the entire lens prompted further observation as to whether the complete opacity would persist indefinitely.

The table and figure 3 summarize the progressive and the regressive changes observed in five groups of rats on different rations. These groups are subdivided with respect to the stage of development of cataract when the animals were changed to a normal diet; subgroup A was changed to a normal diet during the stage of nuclear opacity, and subgroup B, after the stage of complete opacity was reached. Other experimental findings for these groups on various rations have been published elsewhere, and the results were briefly reviewed earlier in this paper. A study of the rate of the cataractous changes has not previously been reported.

3. Regressive Changes.—From the clinical standpoint, cataractous changes in the lens have been considered irreversible. All that non-surgical treatment of cataract has hoped to accomplish has been retardation of the pathologic changes. So far as is known, no systematic record of any regression of opacities in cases of experimental cataract has previously been reported.

Several series of rats from different experimental groups have been retained on the colony ration or some other normal diet for from

seven to twenty-eight weeks for observation of possible regressive changes. A summary as to the number of rats observed, the rations used and the duration of the different types of opacity is included in the table.

Clearing of the cortex at the equator usually began within three weeks after the stage of complete opacity appeared, provided the rats had been transferred to the normal ration. This apparent regression continued until the dense opacity had receded to a nuclear area similar to the progressive stage described as nuclear opacity. In many of the eyes, however, the dense central opacity became as small as a pin-

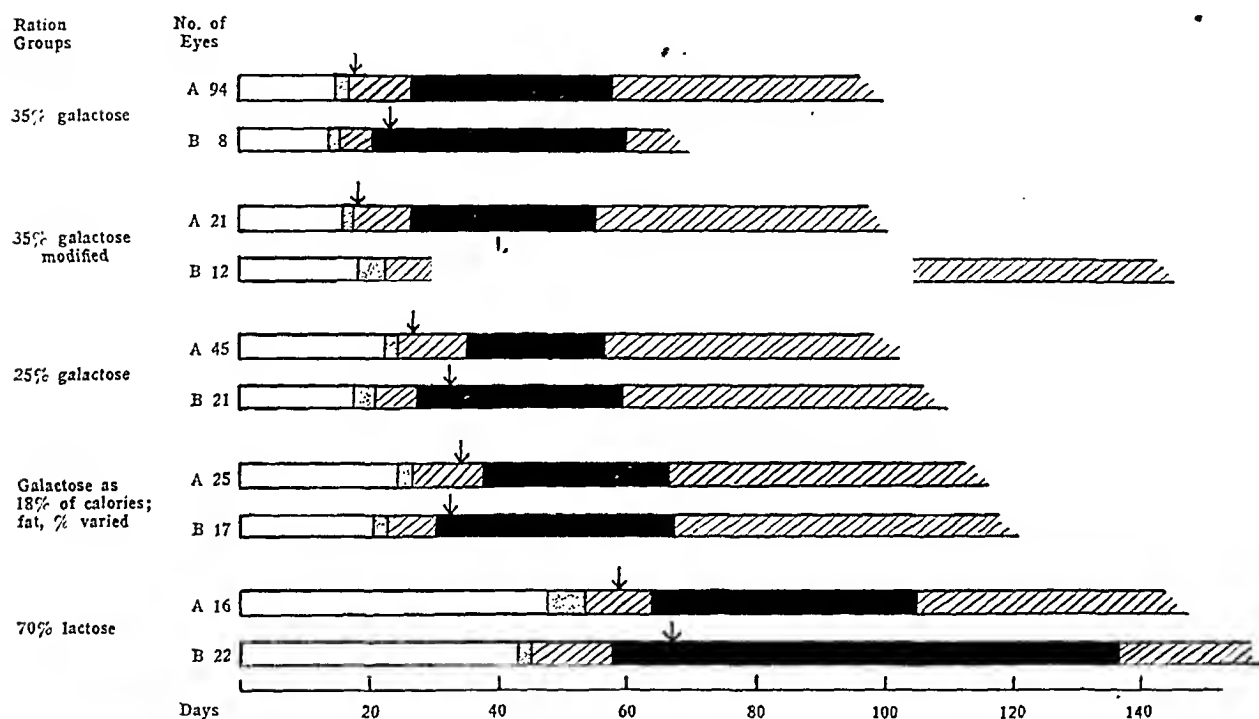


Fig. 3.—Chart showing progressive and regressive cataractous changes in five groups of rats fed different rations. The solid white space indicates no visible opacity; the space with dots, posterior opacity; the space with diagonal lines, dense nuclear opacity, and the solid black space, complete opacity. The arrow indicates change to a normal diet.

head, with the peripheral zone entirely clear. In rare instances this dense white spot seemed to fade until it appeared like an early posterior opacity but was still visible to the naked eye. Drawings to represent certain characteristic stages of regression are shown in figure 4. A cataract which had ever reached the stage of complete opacity never receded to become entirely invisible. So far as has been observed, there is no specific dietary factor that seems to influence materially the speed or the extent of this regression.

A possible explanation of this apparent regression has been suggested. Since the rats were usually 25 days of age when experiments

Stages of Experimental Cataract in Relation to Time

Cataract-Producing Ration	Sub-Group	Number of Eyes Observed	Progressive Changes						Regressive Changes					
			First Appearance of Posterior Opacity		First Appearance of Dense Nuclear Opacity		First Appearance of Complete Opacity		Stage of Opacity When Normal Ration Was Fed	Change to Normal Ration	Duration of Complete Opacity with Normal Ration		Percentage of Eyes Showing Regression	
			Days	Probable Error	Days	Probable Error	Days	Probable Error			Days	Probable Error		
35% galactose.....	A	94	15.0	± 0.3	17.0	± 0.2	27.0	± 0.4	Nuclear	70% starch.....	31.0	± 1.2	93	
	B	8	13.8	± 0	14.5	± 0	20.2	± 0	Complete		36.5	± 0	88	
35% galactose + mineral modifications	A	21	(16.0)†		17.0	± 0.5	26.2	± 0.5	Nuclear	70% starch + mineral modification	29.0	± 2.7	95	
	B	12	(19.0)		22.6	± 0.9	30.0	± 1.4	Complete		64.0	± 4.3	83	
25% galactose.....	A	45	22.6	± 0.5	24.6	± 0.5	36.0	± 0.7	Nuclear	70% starch or stock ration*	20.6	± 0.8	100	
	B	21	17.9	± 0.5	20.8	± 0.5	27.5	± 0.6	Complete		27.0	± 2.1	90	
Galactose = 18% of calories; fat, % varied	A	25	25.5	± 0.4	27.1	± 0.4	38.5	± 1.4	Nuclear	Stock ration*.....	28.1	± 1.1	100	
	B	17	20.6	± 0.4	22.5	± 0.4	30.6	± 0.4	Complete		35.4	± 4.6	94	
70% lactose.....	A	16	(48.0)†		54.2	± 2.2	64.5	± 2.0	Nuclear	70% starch or stock ration*	40.7	± 3.1	93	
	B	22	(43.0)		44.1	± 1.7	58.3	± 1.8	Complete		69.4	± 4.1	46	

* Colony breeding ration adequate for normal growth and reproduction.

† Limited data available—posterior stage not observed.

were started and remained on cataract-producing rations but a few weeks, they were not adult animals when this regressive change was observed. Thus in all probability some normal lenticular fibers capable of growth may have remained at the equator. Such growth would produce clear lens material and tend to cause the opacity to become more deeply placed in the lens. In the group of rats fed the ration containing 70 per cent lactose, cataract developed more slowly than in the others, and the animals were therefore older than the others when the normal ration was resumed. In subgroup B the complete opacity lasted longer and the number of eyes showing regressive changes was less than in the animals of subgroup A, which facts tend to bear out the aforementioned theory in that regressive changes were slower and less evident in these older animals.

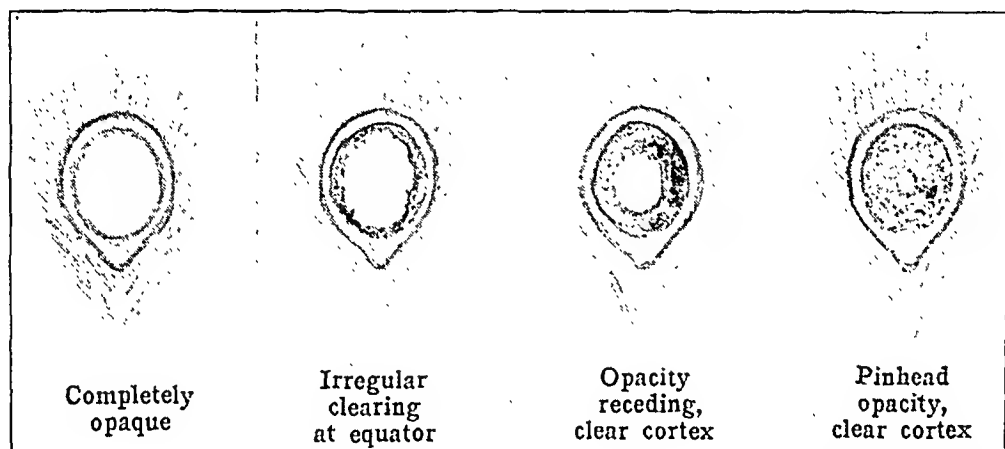


Fig. 4.—Apparent regressive changes in a lens of a rat fed the normal colony ration after cataract had been produced by feeding galactose.

Regressive changes may be related to the degree or the duration of the injury as well as to the age of the animal. The eyes of rats which remained on the cataract-producing ration for several days after the stage of complete opacity had been reached were usually slower to show regression than the eyes of the other rats. The opacities in two such groups were recorded as complete from three to twenty-six days before the change to a normal ration and remained complete for an average of sixty-four and sixty-nine and four-tenths days, respectively, after the change, whereas for corresponding groups changed to a normal ration at the nuclear stage, complete opacity lasted only twenty-nine and forty and seven-tenths days, respectively. Thus it would seem that the severity of the injury may increase beyond that evident from casual inspection and that the prolonged feeding of the aggravating factor may decrease the speed or the extent of regression possible. Sufficient data are not available to warrant any sweeping conclusions on this point.

In a few instances drugs recommended clinically for the nonsurgical treatment of cataract were administered by instillation in suitable dosage to certain rats with mature cataract, while litter mates were maintained as controls. No variation in the rate of regression was observed. Negative results were obtained with thyroxin and with a 1/5,000 solution of mercuric cyanide applied locally. The injection of lens antigen prepared from beef, guinea-pig and rat lenses also failed to exert any noticeable effect.

COMMENT

No systematic review of experimental work on cataract has been attempted in this paper, but rather a brief account of developments in one attack on the subject has been given. Personal conferences and comparison of our results with those of Day, who has published several reports of work on vitamin G deficiency cataract, have failed to uncover a common etiologic factor. The stages in the development of opacities and the final appearance of the mature cataract seem to differ somewhat between the galactose and the vitamin G deficiency type. Discussion and criticism from the ophthalmologist's point of view of the findings reported here will be welcomed. There is no reason to believe that there is any opportunity for immediate clinical application of these findings. As a result of these studies, however, numerous problems of a fundamental nature have arisen and warrant further investigation.

SUMMARY

The rat has proved to be a suitable animal to use for research on cataract because in this species opacities of the lens may develop as a result of certain nutritional disturbances, while spontaneous cataract is rare.

Galactose cataract resulting from feeding either lactose at high levels or galactose at lower levels should be distinguished from vitamin G deficiency cataract. Both may be considered nutritional.

A variation in the susceptibility of different strains of rats to galactose cataract and a lesser but significant variation between litters are of sufficient magnitude to demand the attention of all workers in the planning of experiments and in the interpretation of results.

Studies of the sugar contents of the blood and urine have demonstrated that galactose is the sugar responsible for the high sugar contents of the blood and urine observed in rats fed lactose or galactose rations and that it must be the major etiologic factor in galactose cataract.

One dietary factor which seems to alter the rate of development or the incidence of galactose cataract is protein. A low protein ration (5 per cent) appreciably hastens the development of opacities of the

lens, and a high protein ration and to a lesser extent a high intake of cystine tend to retard this pathologic change.

Other factors, including excess or deficiency of certain relevant vitamins, have failed to alter the cataract-producing action of galactose.

The earliest lenticular change in rapidly developing cataract is a dense vacuolated film originating at the equator and extending over a large portion of the anterior cortex of the lens, which film later disintegrates as large vacuoles and disappears before visible opacities develop.

The successive stages of development of the opacity visible to the naked eye are posterior opacity, dense nuclear opacity and complete opacity. A study of extensive data has been made as to the rate of change and the factors affecting it.

Regression from the stage of complete opacity to that of dense nuclear opacity has been observed in a large proportion of these experimental animals, but no specific dietary factor or local medicament has seemed to alter the speed or the extent of this regressive change. The age of the animal and the extent of the injury, however, do seem to influence the rate of apparent regression of the opaque area.

TUBEROUS SCLEROSIS WITH RETINAL TUMOR

REPORT OF A CASE

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AND

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Probably the earliest record of recognition of cerebral sclerosis associated with retinal tumor was described by von Recklinghausen¹ in 1863. At this time he described having observed a large number of sclerotic areas in the brain of a newly born child and in the same case several myomas growing from the cardiac muscle. Hartdegen² in 1881 described a child 2 years old who died in convulsions; autopsy revealed areas of sclerosis throughout the cerebral cortex, as well as a number of small tumors projecting into the lateral ventricles.

Bourneville,³ in a series of publications between 1881 and 1898, drew attention to a rare form of multiple cerebral sclerosis occurring in young patients who had shown during life mental deficiency and epilepsy. This condition he called tuberous sclerosis. In his subsequent reports covering the autopsies of ten patients he confirmed the association of grayish white subcapsular tumors of the kidney with tuberous sclerosis, and growths were also noted in the heart, spleen and lungs. He also noted in most of his cases the coexistence of adenoma sebaceum, a cutaneous condition described by Pringle⁴ as a hyperplasia of certain elements in the skin, distributed in a curious butterfly fashion on the face.

Schuster⁵ distinguished five different types of lesions of the skin other than adenoma sebaceum, occurring in tuberous sclerosis, which he considered practically pathognomonic of this disease, namely: (1) gooseskin areas varying in size from that of a quarter to that of half a

From the service of Dr. Webb W. Weeks, Department of Ophthalmology, the Bellevue Hospital, New York.

Read at the meeting of the Section of Ophthalmology of the New York Academy of Medicine, April 19, 1937.

1. von Recklinghausen: *Verhandl. d. Gesellsch. f. Geburtsch. in Berlin* **15**:75, 1863.

2. Hartdegen: *Arch. f. Psychiat.* **11**:117, 1881.

3. Bourneville: *Arch. de neurol.* **1**:81, 1880-1881.

4. Pringle, J. J.: *Brit. J. Dermat.* **2**:1, 1890.

5. Schuster: *Deutsche Ztschr. f. Nervenhe.* **50**:96, 1913.

until the patient enlisted in the Army during the World War. While in the Army he had several epileptic attacks and was discharged as 100 per cent disabled on account of epilepsy. He was later observed in a hospital for a period of eight weeks, where on discharge the diagnosis of his condition was changed to hysteria. The patient had no complaints except that he suffered an epileptic attack about once a month, varying from petit mal to grand mal. On examination of the patient's six children, varying in age from 3 to 16 years, no retinal tumors were found. However, two of the children were found to possess pigmented nevi.

The results of physical examination were essentially negative, except for pedunculated fibromas on the right postaxillary fold and a dark brown, circular, slightly elevated mushroom-like mole, approximately 3 cm. in diameter, on the skin on the lower left costal margin. There were several flat fibromas of the skin on the back. Roentgenograms of the chest and the skull, the Wassermann test of the spinal fluid and blood, a blood count and examination of the urine all gave negative results. Neurologic examination revealed no pathologic changes. The patient's intelligence was normal, and he did not show any mental disorder.

Examination of the eyes showed vision of the right eye to be 20/15 and that of the left eye 20/15. The visual fields were normal. The lids, conjunctiva, cornea, pupil, anterior chamber, iris, lens and vitreous of each eye were normal.

The fundus of the left eye was normal. The disk of the right eye was sharply margined; the color was normal, and the blood vessels on the disk and on the periphery were normal. Approximately 2 disk diameters above the nerve head was a grayish white tumor approximately the size of a normal disk in diameter and elevated from 2 to 3 D. appearing to consist of small glittering drusen. The surface of the growth was tuberos, and the whole tumor looked like a white mulberry.

COMMENT

According to van der Hoeve,¹⁵ the retinal tumor macroscopically usually has the appearance of a white mulberry; i. e., it is made up of little buds which can have very thin roots and perhaps break off and fall into the vitreous. It arises from the nerve fiber layer of the retina and may break through the holes in the membrana limitans interna. The tumor may also be found on the disk.

Microscopically, it is made up of a peculiar kind of cell, which is large, having much protoplasm and a big nucleus and nucleolus. These cells look typical of neither a glial nor a ganglion type of cell, which supports evidence that they are embryonic in character. The tumor contains spaces without a special wall, filled with serum or blood, and may show signs of inflammation but have only a few blood vessels.

That the disease is in all probability a hereditary one has been demonstrated many times, although it may manifest itself in a different and less complete way in direct descendants. Because of this fact the family history can play a great role in helping to make the diagnosis. Van der Hoeve¹⁶ traced the disease through three genera-

15. van der Hoeve, J.: *Tr. Ophth. Soc. U. Kingdom* **52**:1380, 1932.

16. van der Hoeve, J.: *Arch. f. Ophth.* **111**:1, 1923.

tions at one time. According to Critchley and Earl,¹⁷ the family history often shows no evidence of tuberous sclerosis but may show a strong psychopathic taint, and epilepsy and alcoholism are common. In their series of reported cases, they were able to obtain a family history in twenty, in thirteen of which there were marks of psychopathy. As the disease may manifest itself in different forms and incompletely in different members of the same family, Critchley and Earl¹⁷ in their extensive monograph on the subject suggested that one is justified in recording the following types as probably representing incomplete forms of tuberous sclerosis: (1) adenoma sebaceum alone; (2) adenoma sebaceum associated with epilepsy but with no mental change; (3) adenoma sebaceum associated with symptoms of cerebral tumor, and (4) visceral tumor alone, including retinal tumor.

The fact that after the diagnosis had been made in the case just reported one other patient, who will be reported on elsewhere, came to autopsy, and two other patients seen by us had a condition that seemed to be tuberous sclerosis of the brain, it appears to us that this is a far more frequent disease than the few reports in the ophthalmologic literature would lead one to expect. If the symptomatology of this disease and its formes frustes become generally known, the diagnosis will be made more often and many cases of grand mal or petit mal made clear.

SUMMARY

A case of tuberous sclerosis of the brain with retinal tumor is reported. Nitsch⁷ in 1927 was the first to diagnose this disease with the use of the ophthalmoscope, although previously retinal tumors had frequently been found in known cases of tuberous sclerosis. This condition is a heredofamilial disease associated with mental deficiency, manifested by cerebral symptoms varying in degree from "absences" to petit mal and grand mal. Other manifestations are Pringle's⁴ nodules of the face or other fibromas of the skin distributed elsewhere on the body, principally the neck, and fibromas of the heart, kidneys, spleen, lungs and brain, as well as tumors of the retina or the disk. The retinal tumors arise from the nerve fiber layer and protrude into the vitreous and have the appearance of a white mulberry or tapioca-like nodules. Not all patients present complete manifestations. There are many incomplete forms—a factor supporting the opinion that the disease is not very rare and probably less often recognized than it actually occurs.

17. Critchley, M., and Earl, C. J. C.: *Brain* 55:311, 1932.

ADENOMATOUS HYPERPLASIA OF THE EPITHELIUM OF THE CILIARY BODY

REPORT OF A CASE

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AND

PAUL G. MOORE, M.D.

CLEVELAND

A case of hyperplasia of the ciliary epithelium is reported because of several unusual circumstances present. The tumor was unusually large. Its presence was noted before removal of the eye. Except for the presence of cataract, the eye was not diseased. At the time of enucleation of the eye the patient was under 30 years of age. Histologically and clinically this tumor has proved to be benign.

REPORT OF CASE

F. K., a married white woman aged 29 years, was first seen on April 2, 1935.

The patient complained of gradual diminution of vision in the left eye over a period of at least one year. She associated the impairment of vision in the left eye with a blow on the skull over the right parietal region. The previous ocular history was negative. The patient's medical history and physical examination did not reveal anything pertaining to her ocular condition. Uncorrected vision in the right eye was 6/4. The right eye was normal. In the left eye, vision was reduced to perception of light at 20 feet (6 meters). Vision was unimproved by glasses. The tension in the left eye was 18 mm. of mercury (Schiötz). The cornea of the left eye was clear. A dense general opacity of the crystalline lens prevented examination of the fundus. The anterior chamber was shallow. In the region of 6 o'clock, toward the angle of the anterior chamber, a peripheral portion of iris was in contact with the posterior surface of the cornea. In this region the brown iris was more deeply pigmented. Through the pupil a mass of brown pigment was seen, between the iris and a cataractous lens. The pupil was moderately dilated after the instillation of homatropine. The brown pigment seen at the pupillary margin of the iris in the region of 6 o'clock was now revealed to be part of a dense brown mass. This mass extended backward toward the ciliary body. The mass was also in contact with the equator of the lens and the posterior surface of the iris. The lower portion of the lens appeared to be tilted slightly backward. A peripheral portion of the iris was pressed against the cornea. The general opacity of the lens was more dense in the immediate neighborhood of the tumor. In the region of the tumor there was some absorption of transmitted light. A tentative diagnosis of sarcoma of the iris and ciliary body was made. The amount of pigment visible through the pupil increased.

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Western Reserve University.

Vision was reduced to counting fingers at 3 feet (90 cm.). On May 11 the left eye was enucleated. Two years later there was no sign of local extension or general metastasis.

REPORT OF PATHOLOGIC EXAMINATION

The section containing the largest amount of tumor (fig. 1) had its longer axis parallel to the sclera and cornea. This measured 4.5 mm. The tumor projected posteriorly to a depth of 3.6 mm. The mass was well defined in all its margins.

The nodule was circumscribed but not encapsulated and occupied the entire thickness of the corona ciliaris (pars plicata) of the ciliary body, with encroachment on the adjacent iris. The posterior third or more of the iris had been replaced by expansion of the hyperplastic mass. This portion of the iris was in



Fig. 1.—Section of the eye, showing location of the tumor.

contact with the posterior surface of the cornea. The canal of Schlemm and the meshwork of the angle of the anterior chamber were filled by pigment and pigment-bearing atypical cells. Descemet's membrane was uninterrupted, but in the region of the tumor the corneal endothelium had largely disappeared. At the junction of the iris and the cornea, the corneal endothelium was reflected onto the anterior surface of the iris.

The tumor was in contact with and adherent to the equator of the crystalline lens. The crystalline lens was cataractous. A small pigment-covered nodule presented in the anterior chamber between the pupillary margin of the iris and the crystalline lens. The portion of the lens in proximity with the tumor exhibited subcapsular hyperplasia of lenticular fibers. These fibers were dense and hyalinized. Immediately beneath the capsule of the lens, in the region of the tumor, there was a small, narrow, irregular area of basophilic material resembling bone, calcified but not containing bone cells. At one point the capsule of the lens was interrupted, and pigment-bearing cells were present inside the lens.

The nodule was comprised in part of closely disposed cords of cylindric epithelial cells enclosed by moderately heavy collagenous basement membranes, the cells being arranged in rows, forming solid strands or alveoli, or lining structures resembling tubules but without definite lumens. The base of each cell rested on the enclosing basement membrane, and except for the basement membrane there was practically no stroma. The cells had an abundant amount of pale acidophilic cytoplasm, which was homogeneous at the basal, and granular at the distal, poles of the cells. At the periphery of the nodule many of the cells contained fine and coarse granules of dense brown pigment. The cells containing pigment were more pleomorphic than those that were nonpigmented. Some masses of cells showed uniform pigmentation, and in some instances the entire cellular mass had disintegrated, leaving a circumscribed conglomeration of free pigment within an intact basement membrane. In a few instances alveoli were

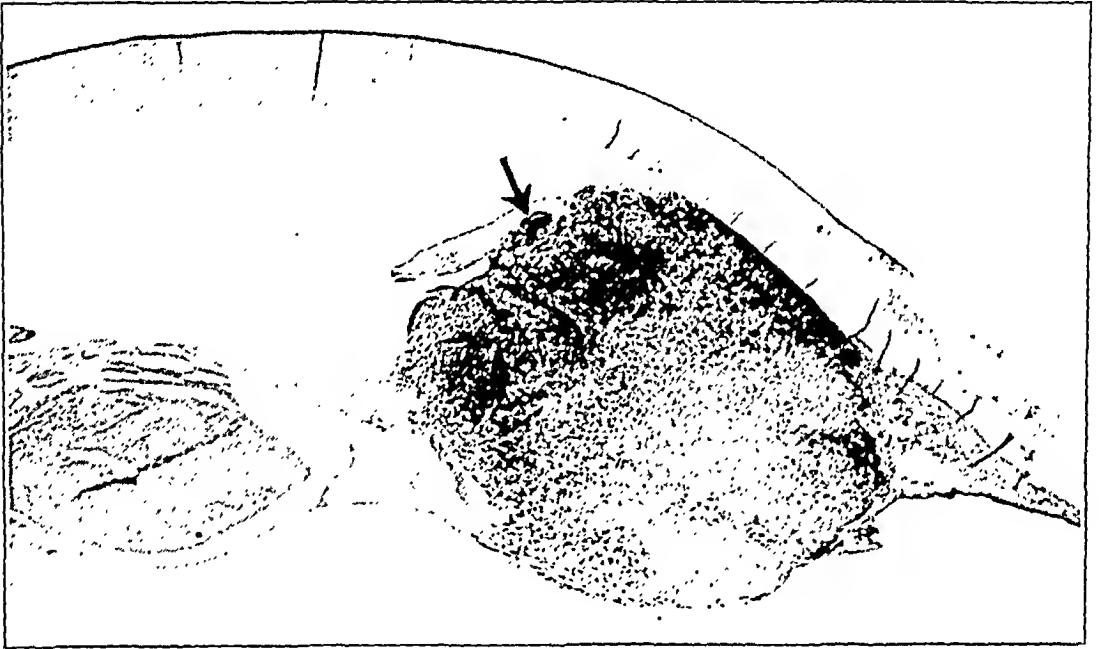


Fig. 2.—A higher magnification of a portion of figure 1. The distribution of pigment in the tumor is shown. The nodule has replaced the corona ciliaris and the posterior portion of the iris. It is adherent to the cornea and the crystalline lens. The canal of Schlemm is represented by a dark streak. The space in the ciliary body is an artefact. \times about 11.

composed of both pigmented and nonpigmented cells, but there was no reproduction of the normal arrangement of ciliary epithelium, in which the basal cell layer is pigmented and the superficial cell layer is nonpigmented. There was no sign of secretory activity. There was no obvious continuity between the strands of cells and the cells covering the surface of the ciliary body. The nuclei were uniformly round, and the chromatin was homogeneously distributed. A basal nuclear polarity was maintained uniformly throughout the cylindric cells of the tumor, and no mitoses were observed. Although there was no capsule, yet the adjacent structures appeared to be displaced and attenuated, rather than invaded, so that the nodule appeared to have expanded by centripetal rather than centrifugal growth.

Few of the tumor cells were entirely free from pigment. The posterior and the central portion of the tumor were relatively free from pigment. The anterior portion of the tumor was deeply pigmented. In the anterior portion of the tumor, particularly near the iris, clusters of approximately a dozen smaller cells with small dense nuclei and deeply stained cytoplasm were seen. These cells suggested immature forms of the larger cells constituting the main mass. In this region the supporting tissue was almost acellular and was in part delicately fibrillar and in part hyalinized. Vascularization by small vessels about the size of capillaries was scanty. In the region of the ciliary body and of the iris the blood supply was best.

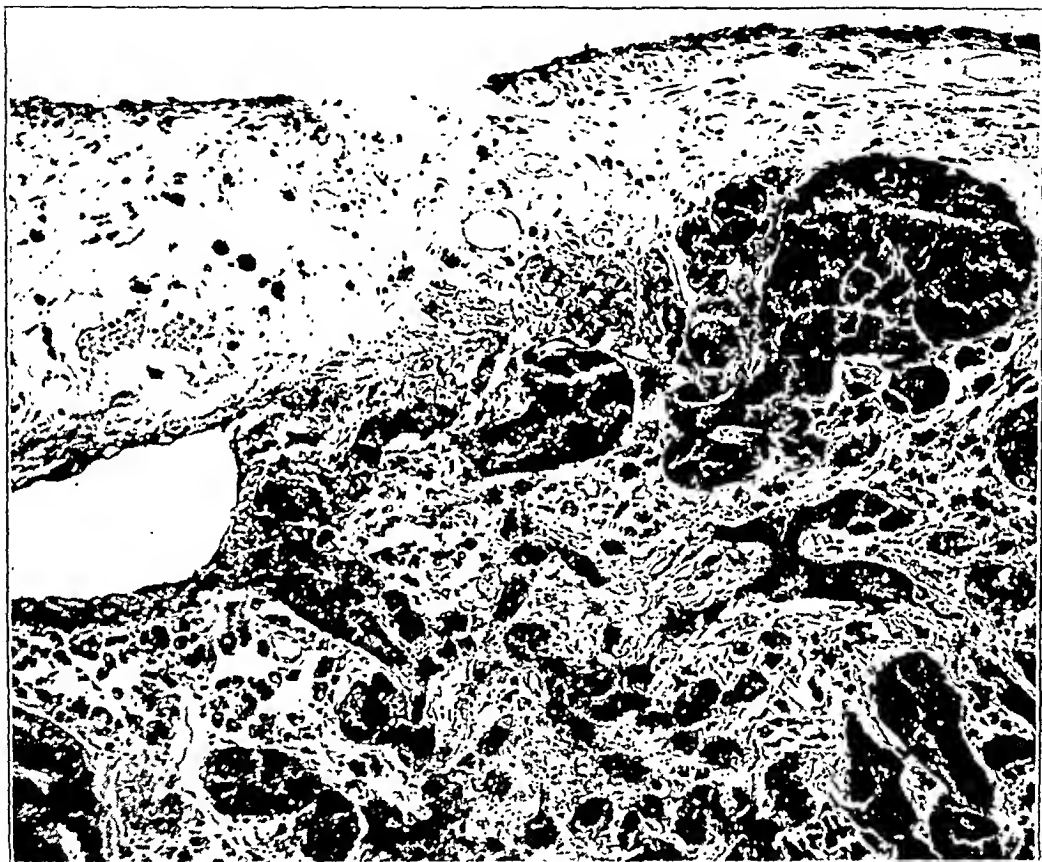


Fig. 3.—A higher magnification of a portion of figure 2, indicated by the arrow. This section demonstrates the relationship between the margin of the tumor and the iris. $\times 135$.

Aside from the presence of the tumor and the cataractous lens, the eye was normal. In the immediate neighborhood of the mass, in the anterior portion of the ciliary body, a blood vessel with a very moderate perivascular accumulation of lymphocytes was noted. In the immediate region of the tumor the blood vessels of the iris showed mild proliferation of the media. In the region of the crystalline lens a degenerative change was apparent. A distinct tendency to hyalinization of adjacent tissues was evident. Except in the region of the growth, the filtration angle of the anterior chamber was patent. In the immediate neighborhood of the tumor the pectinate ligament was very dense and hyalinized. The meshwork of the filtration angle of the anterior chamber, the pectinate ligament, and Schlemm's

canal contained many pigmented and nonpigmented cells. No iron-containing pigment was observed in the tumor. In the iris, adjacent to the tumor, there was proliferation of the "myoglia" cells of the dilator muscle. These cells did not seem to be present in the tumor. The pigment layer of the posterior surface of the iris was reflected on the anterior surface of the tumor. At the anterior edge of the tumor, as it replaced or invaded the iris, it was difficult to identify

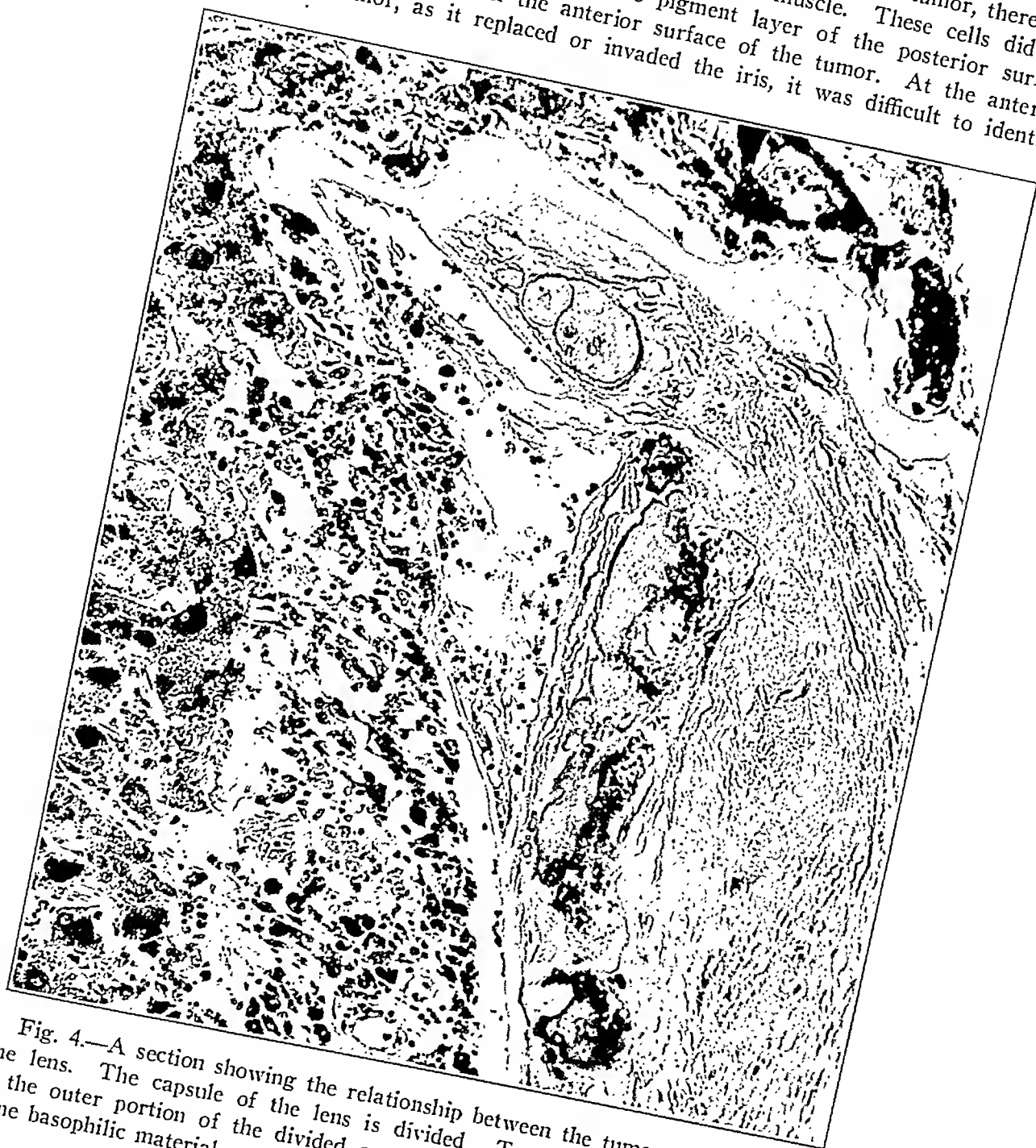


Fig. 4.—A section showing the relationship between the tumor and the crystalline lens. The capsule of the lens is divided. Tumor cells occupy an opening in the outer portion of the divided capsule of the lens. Beneath the capsule is some basophilic material resembling bone. $\times 135$.

the tissue of the iris for any distance within the tumor. A few isolated blood vessels and, possibly, a few connective tissue cells could be seen. The appearance presented was one of replacement rather than invasion of the iris. The fibers of the zonule of Zinn ran across and lay on the inner surface of the tumor. Pigment-

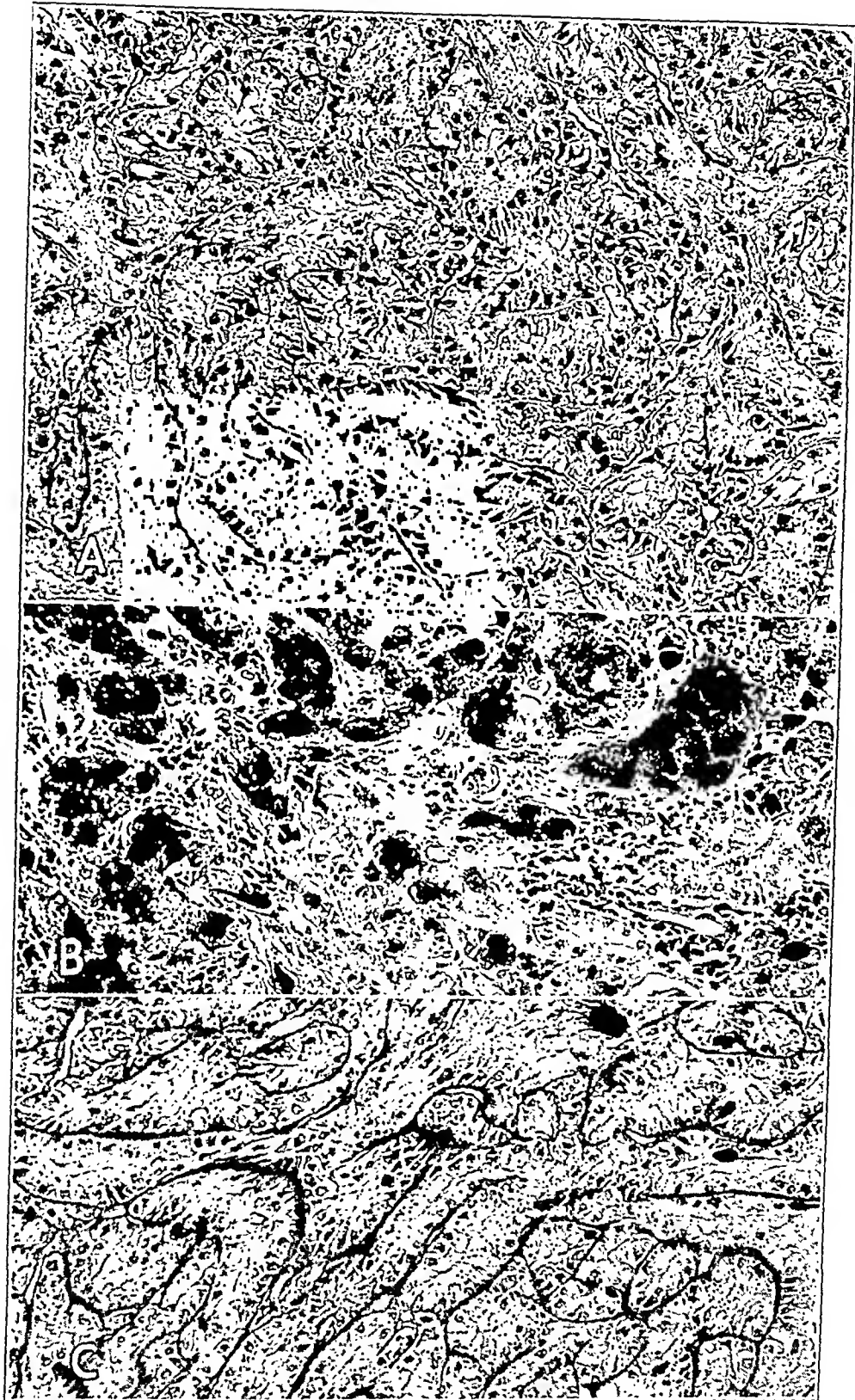


Fig. 5.—*A*, small section from the center of the tumor; hematoxylin and eosin stain; $\times 165$. *B*, section showing the transition from the lightly pigmented to the more heavily pigmented portion of the growth; hematoxylin and eosin stain; $\times 165$. *C*, section of the tumor stained with azocarmine to demonstrate the basement membranes of the cells; $\times 165$.

bearing cells and a few blood vessels were observed among the fibers of the zonule. There were a few pigment-bearing cells in the anterior portion of the vitreous.

The neoplastic character of the mass was indicated solely by the fact that it constituted a nodule of abnormal architecture. It is possible that cellular hyperplasias alone in a situation such as the ciliary body might be present in nodular form. There was no clear indication that this tumor was invasive, and there was no other indication that furnished conclusive evidence of malignancy.

COMMENT

The term "adenomatous" is used to portray the histologic appearance of the tumor, which was that of an adenoma simplex (or solidum) except for the absence of a capsule. The tumor was therefore, strictly speaking, not a true adenoma. It was a nodular hyperplasia of the ciliary epithelium. The cells of the tumor may have a threefold origin: They may arise partly from the pigment layer of the ciliary epithelium, partly from the pigment epithelium of the iris and partly from the non-pigmented epithelium of the ciliary processes. In a normal eye the non-pigmented epithelium of the ciliary processes near the origin of the iris gradually becomes pigmented. This is particularly noticeable on the anterior side of the most anterior of the ciliary processes. Here the internal layer of epithelium abruptly becomes pigmented and passes onto the posterior surface of the iris as a heavily pigmented epithelial layer. In the same position the pigment-bearing epithelial layer of the ciliary processes becomes less pigmented, and at the beginning of the iris this layer of pigment epithelium is replaced by "myoglia," the slightly pigmented cells which constitute the dilator muscle of the iris. It is possible that the nonpigmented epithelium in the anterior portion of the ciliary processes, if hyperplastic, might become pigmented. It is also possible that proliferating pigmented ciliary epithelium might be relatively devoid of pigment.

The etiology of the tumor is obscure. The new growth is possibly an earlier and more extensive form of the small benign epithelial tumor of the ciliary body of Fuchs,¹ first reported by him in 1883, and since found in various forms by several investigators.² The majority of the tumors of the ciliary epithelium reported have been observed accidentally at autopsy or in eyes removed for causes other than the tumor. With a few exceptions, the tumor was present only in the eyes of persons over 50 years of age.

1. Fuchs, E.: *Prolapsus Chorioideae*, Arch. f. Ophth. 29:4, 1883.

2. Ginsberg, S.: *Vom Ziliarepithel ausgehende Tumoren*, in Henke, F., and Lubarsch, O.: *Handbuch der speziellen pathologischen Anatomie und Histologie*, Berlin, Julius Springer, 1928, vol. 11, pt. 1, p. 551.

A few cases of tumor of the ciliary epithelium have been reported in young persons previous to removal of an eye, notably, by R. A. Greeves³ in a 10 year old girl, by M. L. Hine⁴ in a soldier aged 28 years, by V. Petraghani⁵ in a specimen removed for biopsy from the eye of a woman aged 30 years and by W. Zentmayer⁶ in the left eye of a woman aged 56 years. Greeves and Hine considered the tumor in their cases a malignant growth of epithelial origin. Petraghani, and Verhoeff, in studying Zentmayer's specimen microscopically, failed to see any evidence of malignancy.

Clinically, these cases resembled the one reported. The pathologic picture, with the exception of the tumor in the case reported by Hine, was also similar. In discussing Hine's case, Treacher Collins expressed the opinion that the growth was an example of the condition encountered by Greeves. Opacities were present in the crystalline lens in all four instances.

SUMMARY

A case of nodular hyperplasia of the epithelium of the ciliary body of the left eye in an otherwise healthy white woman 29 years of age is reported. The presence of the tumor was noted before removal of the eye. The eye was normal except for the ciliary nodule and a cataract. Hyperplastic ciliary epithelium had formed a large nodule which had replaced the corona ciliaris and the posterior third of the iris. The periphery and the anterior portion of the nodule were heavily pigmented. The central portion of the growth was relatively free from pigment. Two years after removal of the left eye the remaining eye was normal and the patient healthy.

3. Greeves, R. A.: A Rare Case of Primary Malignant Growth of the Ciliary Body, *Tr. Ophth. Soc. U. Kingdom* **31**:261, 1911.

4. Hine, M. L.: Primary Epithelioma of the Ciliary Body, *Tr. Ophth. Soc. U. Kingdom* **40**:146, 1920.

5. Petraghani, Vittorio: Rara neoformazione benigna del corpo ciliare, *Boll. d'ocul.* **14**:1693, 1935.

6. Zentmayer, William: A Case of Hyperplasia of the Epithelium of the Ciliary Processes (Ciliary Adenoma of E. Treacher Collins), *Arch. Ophth.* **16**:677 (Oct.) 1936.

VITAMIN D AND MYOPIA

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Many theories have been advanced for the etiology of myopia. Some (Arlt, Branner and Heinonen) believe that continued use of the eyes for close work, such as reading and sewing, causes elongation of the globe as a result of compression by the internal rectus muscle. Others believe that the general physical condition of city dwellers is inductive to the development of myopia (Steiger). Some insist that the intra-ocular tension is increased by prolonged near work, with resultant stretching of the posterior pole of the eye, and this accounts for the prescribing of miotics by some ophthalmologists in cases of myopia (Mayer). Levinsohn is the chief protagonist of the view that by persistently keeping the head bent downward in reading and sewing the eyeball is made to stretch in its antero-posterior diameter, the posterior pole bearing the brunt.

These views really belong in the category of mechanical influence causing stretching of the eye. Opposed to this is the belief as expressed by Vogt, for example, that the myopic changes in the fundus occur in patients who are biologically and by heredity predisposed to these degenerative stigmas, which are of the same nature as senile changes occurring in the region of the posterior pole. In other words, there is extremely early development of senile changes in the eyes of certain young persons which causes myopia. Couadau decided that heredity plays a part in transmitting the feebleness of resistance of the sclera, and this is also the opinion of Tscherning and Comberg.

Luedde claimed that by dissociation of the two eyes in near vision through monocular cycloplegia, consistently excellent effects were obtained over a period of eight years for myopic patients. He based his work on Jackson's statement that "excessive convergence in the great majority of cases starts the myopia and keeps it progressive" and also on Donder's explanation of the exemption from myopia of watchmakers who use a monocular loupe. Luedde also feels that "a sclera with less than average resistance yields to the increased intra-ocular pressure incident to extra-ocular muscular action in sustained and excessive convergence."

- The stroma of the sclera and cornea consists mainly of fibrous tissue. Some elastic tissue is also present, of negligible amount in the

sclera, but a moderate number of elastic fibers are present in the cornea. As regards the amount of calcium in the cornea and sclera, no chemical determinations have been made. According to a personal communication received from Steenbock in 1931, no chemical determination of the amount of calcium in the cornea or the sclera of any animals on a diet deficient in vitamin D had been made up to that time. To my knowledge, none has been made since that date. In 1934, acting on a suggestion from me that I had been experimenting clinically with the use of viosterol (vitamin D) in early cases of myopia and keratoconus, Blackberg and Knapp published the results of their findings in the eyes of young dogs which had been on a diet deficient in vitamin D and calcium. Their studies included clinical and microscopic examinations, which showed "prominence of the eyeball, widening of the palpebral fissure, episcleral injection, primary ectasia of the cornea, deepening of the anterior chamber, and swollen, muddy iris." Microscopically there were irregularity and edema of the stroma of the cornea, and edema of the fibrous tissue of the sclera, resulting in swelling. However, it is still not known whether the amount of calcium in the cornea and sclera was changed as a result of the vitamin D and calcium dietary deficiency.

As regards the role of vitamin D and calcium metabolism in the development of myopia, it is common knowledge that at times during pregnancy the amount of myopia increases. Furthermore, the utilization of the mother's calcium for the development of the fetus sometimes causes a depletion of the calcium reserve of the pregnant woman, and changes in the teeth may occur. Macy has shown that a large intake of vitamin D during pregnancy is of importance to the mother. A clinical entity which emphasizes the connection between the sclera and the bones, and thus possibly the importance of calcium metabolism for the sclera, is the syndrome of blue scleras and brittle bones, in which condition deafness and marked relaxation of the ligaments are often present (Hills and McLanahan). To complete the picture it would be necessary only to report that patients with blue scleras are all myopes, owing to the thinning and stretching of the sclera. However, it must be remembered that the blueness and thinning take place in the anterior segment of the globe, in the region of the ciliary body, and that the stretching, if any, would be in the transverse, and not in the antero-posterior, diameter. This suggests that some of these patients might have subluxated lenses due to pulling and possibly tearing of the zonular fibers. However, I have not been able to find any cases of such a condition reported, nor have I seen any subluxation in the eyes with blue scleras that I have examined. I am reminded particularly of one Negro child 6 years old whose scleras in the anterior segments were

so blue that it seemed that methylene blue must have been splashed over them. This child had normal lenses in normal position and was not myopic.

These facts—(1) the changes in the teeth of pregnant women plus occasional increase in myopia; (2) the association of thin, blue scleras with brittle bones; (3) the development of myopia most often during adolescence, when there is an increased rate of growth, with subsequent increased demand on the tissues, and (4) the microscopic changes which occur in the fibrous tunic of the eye when there is depletion of vitamin D—all suggest the clinical use of vitamin D to arrest the development of myopia.

In March 1933 I wrote to the chief editor of the ARCHIVES to the effect that since 1930 I had been using vitamin D and calcium in cases of myopia and keratoconus, with what I then considered most encouraging results. This communication was prompted by reading an abstract of Walker's article in the *British Journal of Ophthalmology*, in which he stated that he believed that progressive myopia was due to inherent weakness of the sclera. Some of his patients also had dental caries due to calcium deficiency. He wrote that he had been prescribing calcium for three years, with "suggestive and promising results," and also mentioned that D. J. Wood had suggested using calcium together with parathyroid extract.

Since the relation of vitamin D to the prevention of rickets has been definitely established, this vitamin, together with calcium, has been prescribed not only for rickets but in other bone conditions in which calcium metabolism has been impaired. It is also being used in dentistry in the hope (sic) that it will prevent the formation of cavities in the young. And it also is prescribed in those cases in which one wishes to increase the absorption and utilization of calcium. The most common form in which it is used is drops of viosterol. Often it is given in combination with vitamin A as cod liver oil with viosterol or as halibut liver (haliver) oil with viosterol. The latter (haliver oil) is usually given in concentrated form in small perles. Cod liver oil is given in its natural form, unconcentrated, with viosterol added to it.

According to the Council on Dental Therapeutics of the American Dental Association, "cod liver oil has a favorable influence on the absorption and subsequent deposition of calcium and phosphorus in the bones and in the teeth." The council concluded that "empirical prophylaxis by regulation of the diet of the children is distinctly effective in combating caries and, at least until the problem becomes more fully understood, deserves more universal adoption." Furthermore, they also decided that "there is no carefully controlled evidence that the addition of calcium and phosphorus compounds, whether inorganic or organic,

promote retention of these elements . . . except in known cases of deficiency. Where this occurs, milk serves as an excellent source of calcium and phosphorus in a readily assimilable form."

CLINICAL EXPERIMENTS

I have been using 10 drops of viosterol daily as the source of vitamin D plus a quart of milk daily as the source of calcium for all patients with myopia up to the age of 17 years. At one time I used vitamin D milk, but the amount of vitamin D in a quart of milk is variable, as *The Journal of the American Medical Association* has often pointed out. Of course, the younger the patient when he presents himself for treatment the better one can judge the merits of this therapeutic method. Some patients have refused viosterol because of its oily character, and for these patients I have ordered one perle of concentrated haliver oil with viosterol. It is true that vitamin A is added when the perles are used, but this makes no difference in evaluating the usefulness of vitamin D for myopic patients. I have not used this form of therapy for clinic patients but have confined its use to private patients only, because, first, the cost of the drops of viosterol is something to be considered and, second, private patients are controlled more easily and will cooperate more readily than clinic patients.

During the past six years there have been eighty-six myopic patients whom I have considered young enough for a trial with vitamin D and milk. Of these, twenty were seen during 1936, and these will not be included in this report, as the interval of treatment was too short. Of the remaining sixty-six, eighteen have not returned or have not taken the viosterol continuously enough to warrant inclusion in this study. That leaves forty-eight patients who have taken vitamin D and milk continuously and have been seen at nine month intervals for from three to six years.

Of these forty-eight patients, there were twelve between the ages of 5 and 10 years, twenty-five between the ages of 10 and 14 years and eleven between the ages of 14 and 17 years, when first seen. In stating the total amount of the myopia, the spherical and cylindric powers will be added together, so that a -0.50 D. sphere together with a -1.00 D. cylinder will be considered as indicating 1.50 D. of total myopia. Among the twelve patients between the ages of 5 and 10 years, the amount of myopia present when the patient was first seen varied between 0.50 and 2.00 D. In every one of these patients during the three to six years that they have been under observation with a daily intake of viosterol and milk there has been an increase in the amount of the myopia. In some the increase has been only 1.00 D.; in others it has been as much as 2.50 D., but not one patient has had

a decrease in the amount of the myopia or even an arrest of the progress. Among the twenty-five patients between the ages of 10 and 14 years, the myopia when the patient was first seen varied between 0.50 and 3.00 D. In these, also, there has been an increase in the myopia, ranging from 0.50 to 2.50 D., but in not one of them has the total myopia increased to above 6 D. The eleven patients of the last group, those between 14 and 17 years of age, had a total myopia of from 1.00 to 4.00 D. when first seen. In these the increase has been the least—from 0.50 to 2.00 D.—but again there were no instances of diminution and no complete arrest before the age of 20.

I wish to cite one case in full as fairly descriptive of all the others.

S. B., was first seen in April 1930 at the age of 13 years, at which time her right eye had normal vision with a -2.25 D. sph. \ominus -1.50 D. cyl., ax. 15, and the left eye had normal vision with a -0.25 D. sph. \ominus -0.50 D. cyl., ax. 165.

Summary of Myopic Progress of Patient

Date	Correction for Right Eye		Correction for Left Eye		
	Sph., D.	Cyl., D.	Sph., D.	Cyl., D.	
April 1930.....	-2.25	\ominus -1.50	-0.25	\ominus -0.50	Viosterol given
December 1930.....	-2.50	\ominus -1.50	-1.00	\ominus -0.50	
August 1932.....	-2.50	\ominus -1.50	-1.50	\ominus -0.50	Viosterol discontinued
May 1933.....	-2.75	\ominus -1.50	-1.75	\ominus -0.50	
January 1934.....	-3.00	\ominus -1.50	-2.00	\ominus -0.50	
December 1934.....	-3.00	\ominus -2.00	-2.25	\ominus -1.00	
March 1936.....	-3.25	\ominus -2.00	-2.25	\ominus -1.00	
February 1937.....	-3.25	\ominus -2.00	-2.25	\ominus -1.00	

She was put on viosterol and milk. The table gives a summary of her myopic progress.

The patient is now 20 years old; the viosterol and milk were discontinued in 1934, at the age of 17. The total myopia of the right eye at the age of 13 years was -3.75 D., and that of the left eye was -0.75 D. Four years later, at the age of 17, the total myopia for the right eye was -5.00 D., and that of the left eye was -3.25 D. Three years later, at the age of 20, the total myopia of the right eye was -5.25 D., and that of the left eye was -3.25 D. During the four years that the viosterol and milk were taken, between the ages of 13 and 17 years, the myopia of the right eye increased by 1.25 D., and the myopia of the left eye increased by 2.50 D. During the next three years, between the ages of 17 and 20, during which time no viosterol was taken, the myopia of the right eye increased by 0.25 D., and that of the left eye was stationary.

The case just cited certainly yields no startling data, since many patients without any treatment and often without wearing glasses constantly have no greater increase in the total myopia than the patient here described. This is the usual progress in cases of myopia: The amount of myopia increases during adolescence up to about the age of 17 or 18 years, and after that it is usually stationary. All the patients

not only took viosterol and milk daily but also wore the glasses constantly. Furthermore, they were instructed to do as little reading as possible; their posture while reading was corrected, and the lighting was checked. All these hygienic measures were of no avail in arresting the progress of the myopia.

CONCLUSIONS

Again I must admit disappointment in the use of vitamins for certain ocular disorders, recalling that in retinitis pigmentosa I (Levine) had no success with the use of vitamin A. Accordingly, I must disagree with those who say that treatment with vitamin D and calcium helps patients who have myopia by reducing the amount of the myopia, keeping it stationary or preventing as rapid an increase as is usually found in patients who have not used this form of therapy.

BIBLIOGRAPHY

- Arlt, C. F.: Ueber die Ursachen und die Entstehung der Kurzsichtigkeit, Vienna, Wilhelm Braumüller, 1876.
- Blackberg, S. N., and Knapp, A. A.: Ocular Changes Accompanying Disturbances of Phosphorus-Calcium Metabolism, *Arch. Ophthalm.* **11**:665 (April) 1934.
- The Influence of Vitamin D—Calcium-Phosphorus Complex in the Production of Ocular Pathology, *Am. J. Ophthalm.* **20**:405 (April) 1937.
- Branner, J.: Ueber die degenerativen Stigmata hochgradig Myoper, *Klin. Monatsbl. f. Augenh.* **90**:527 (April) 1933.
- Calcium Therapy in Dentistry, editorial, *J. A. M. A.* **108**:1655 (May 8) 1937.
- Comberg, W.: Anatomische und experimentelle Untersuchungen über die mechanischen Faktoren der Myopiegenese, *Ber. ü. d. Versamml. d. deutsch. ophthalm. Gesellsch.* (1928) **47**:126, 1929.
- Couadau, A.: La myopie monolatérale, Paris, J. B. Baillière et fils, 1929, p. 119.
- Donders, F. C.: Die Anomalien der Refraktion und Akkommodation des Auges: Zweiter Abdruck der unter Mitwirkung des Verfassers von Prof. Dr. Becker herausgegebenen deutschen Originalausgabe, Vienna, Wilhelm Braumüller, 1888, p. 350.
- Heinonen, O.: Etiology of School and Occupation Myopia, *Acta ophthalm.* **6**:238, 1928.
- Hills, R. G., and McLanahan, S.: Brittle Bones and Blue Scleras in Five Generations, *Arch. Int. Med.* **59**:41 (Jan.) 1937.
- Jackson, Edward: Norms of Refraction, *Tr. Sect. Ophthalm., A. M. A.*, 1931, p. 174.
- Levine, Joseph: Is Retinitis Pigmentosa Due to Vitamin Deficiency? *Arch. Ophthalm.* **9**:453 (March) 1933.
- Progressive Myopia, *ibid.* **9**:459 (March) 1933.
- Levinsohn, G.: Die Entstehung der Kurzsichtigkeit, Berlin, S. Karger, 1912.
- Luedde, W. H.: Monocular Cycloplegia for the Control of Myopia, *Am. J. Ophthalm.* **15**:603 (July) 1932.
- Macy, I. G.; Hunscher, H. A.; McCosh, S. S., and Nims, B.: Metabolism of Women During Reproductive Cycle: Calcium, Phosphorus, and Nitrogen Utilization in Lactation Before and After Supplementing Usual Home Diets with Cod Liver Oil and Yeast, *J. Biol. Chem.* **86**:59 (March) 1930.
- Mayer, Leo L.: Epinephrine in Progressive Myopia, *Am. J. Ophthalm.* **14**:908 (Sept.): 1015 (Oct.) 1931; **15**:35 (Jan.) 1932.

The expression $\frac{n' - n}{r}$ is called the surface power; it may be denoted by D_s .

The (linear) magnification, m , which is defined as the ratio $\frac{I}{O}$ (the size of the image, I , divided by the size of the object, O), is for a single spherical refracting surface given by

$$(2) \quad m = \frac{nv}{n'u}.$$

When these formulas are applied successively to the surface powers D_1 (front surface) and D_2 (back surface) of a single lens of center thickness t and a glass index of refraction n , the result is

$$(3) \quad v = \frac{Cu + D}{Au + B}$$

and

$$(4) \quad m = \frac{1}{Au + B},$$

where the letters A , B , C and D are defined by the following relations:

$$A = D_1 + D_2 - dD_1D_2$$

$$B = 1 - dD_2$$

$$C = 1 - dD_1$$

$$D = -d = -\frac{t}{n}.$$

The distance of the object, u , is measured from the vertex of the front surface, and the distance of the image, v , is measured from the vertex of the back surface.

The most important case arises when the object is so far removed that u may be considered "infinite." Then, according to formula 3,

$$v = \frac{C}{A} = \frac{1 - dD_1}{D_1 + D_2 - dD_1D_2} \quad u \rightarrow \infty.$$

This expression is called the back focal length of the lens. It is the distance from the back vertex to the so-called second principal focus of the lens. The reciprocal of the back focal length, namely,

$$(5) \quad \frac{A}{C} = \frac{D_1 + D_2 - dD_1D_2}{1 - dD_1} = \frac{D_1}{1 - dD_1} + D_2 = D_e$$

is called the vertex or effective power of the lens, denoted here by D_e .

When u becomes infinite, the magnification, m , tends to zero unless the size of the object, O , also becomes infinite. In this event, in which the object may subtend an angle, w , at the lens, the size of the corresponding image is given by

$$(6) \quad I = \frac{w}{A} = wf'.$$

The magnitude, which is symbolized by $A = D_1 + D_2 - dD_1D_2$, is called the equivalent focal power, and its reciprocal, f' , is called the equivalent focal length. It is measured from the second principal point

of the lens to the principal focus. The second principal point is located at a distance

$$(7) \quad \frac{C-1}{A} = \frac{-dD_1}{D_1 + D_2 - dD_1D_2}$$

from the back vertex of the lens.

If two systems of equivalent focal powers, A and A_o , are given, the equivalent focal power, A' , of the combined (centered) system is expressed by the formula

$$(8) \quad A' = A + A_o - tAA_o,$$

where t is the distance from the second principal point of the system A to the first principal point of the system A_o . This formula is of special importance in ophthalmic optics, because the spectacle lens and the eye form a combination of two optical systems.

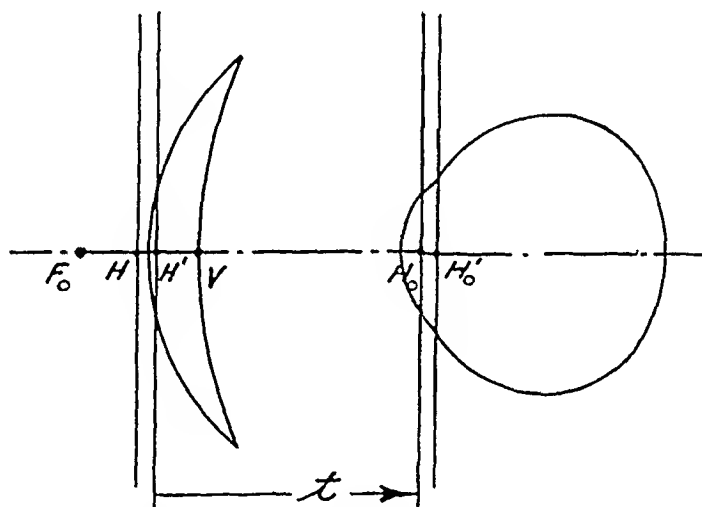


Fig. 1.—Diagram illustrating the formula $t = H'H_o = H'V + VF_o + F_oH_o$, where V represents the back vertex of the lens, F_o the anterior focus of the eye and H_o the first principal point of the eye.

According to formula 6, the size of the retinal image which an emmetropic eye of equivalent focal power, A_o , produces of a far distant object subtending an angle, w , is

$$I_o = \frac{w}{A_o}.$$

An axially ametropic eye wearing a corrective glass of effective power, D_e , at a distance h mm. in front of the cornea produces a retinal image of the same object of

$$I_a = \frac{w}{A'},$$

where A' is defined by formula 8.

A comparison between these retinal images gives

$$\frac{I_a}{I_o} = \frac{A_o}{A'}.$$

In order to gain a clearer conception of this ratio, A' is transformed in the following way (illustrated in fig. 1):

The quantity t in

$$A' = A + A_o - tAA_o$$

may be written

$$t = H'H_o = H'V + VF_o + F_oH_o.$$

In this expression V represents the back vertex of the lens; F_o , the anterior focus of the eye, and H_o , the first principal point of the eye.

According to formula 7, $H'V = -\frac{C-1}{A}$; $F_oH_o = -f_o = f_o' = \frac{1}{A_o}$, and F_oV , the distance from the anterior focal point of the eye to the back vertex of the corrective lens, may be designated by z . Then

$$\begin{aligned} A' &= A + A_o - \left(-\frac{C-1}{A} - z + \frac{1}{A_o}\right)AA_o \\ &= A + A_o + CA_o - A_o + zAA_o - A \\ &= CA_o + zAA_o. \end{aligned}$$

Since, according to formula 5, $A = CD_e$, the last expression may be written

$$A' = CA_o + zCD_eA_o = CA_o(1 + zD_e),$$

and the ratio $\frac{I_a}{I_e} = \frac{A_o}{A'}$, which may be called the magnification of the retinal image of the corrected axially ametropic eye as compared to the retinal image of an emmetropic eye, becomes

$$(9) \quad \frac{I_a}{I_e} = \frac{1}{C(1 + zD_e)}.$$

The factor $\frac{1}{C}$ is called the shape magnification of the corrective lens (E. D. Tillyer) and is designated by S ; that is,

$$(10) \quad S = \frac{1}{C} = \frac{1}{1 - dD_l}.$$

The factor $\frac{1}{1 + zD_e}$ may be called the power magnification of the combined system (the corrective lens plus the eye) and may be designated by P ; that is,

$$P = \frac{1}{1 + zD_e}.$$

Formula 9 may be symbolized, therefore, by

$$\frac{I_a}{I_e} = S \cdot P.$$

If the distance from F_o , the anterior focus of the eye, to the cornea is assumed to be 15.71 mm. (Gullstrand), the quantity z is defined by the equation

$$z = \frac{15.71 - h}{1,000},$$

in which h is in millimeters, the distance from the back vertex of the lens to the cornea. In the majority of cases the value of h lies between 12 and 14 mm.; consequently, the value of z is usually small. Since $d (= \frac{t}{n})$, the "reduced" thickness of the lens, is also small, the percentage by which I_a differs from I_e is approximately

$$(11) \quad \% \text{ mag.} = \frac{dD_l + zD_e}{10},$$

where d and z are to be expressed in millimeters.

CORRECTION OF AN AMETROPIC EYE BY A CONTACT LENS

In order to apply the preceding results to contact lenses, it is to be observed that correction of ametropia by contact lenses may be considered to be achieved by the combination of two lenses: The glass lens, that is, the corneal portion of the contact lens proper and a fluid lens consisting of physiologic solution of sodium chloride. The front surface of the fluid lens is formed by the back surface of the glass lens, and the back surface of the fluid lens is formed by the cornea of the eye (fig. 2). From a theoretical point of view, it will be advantageous to

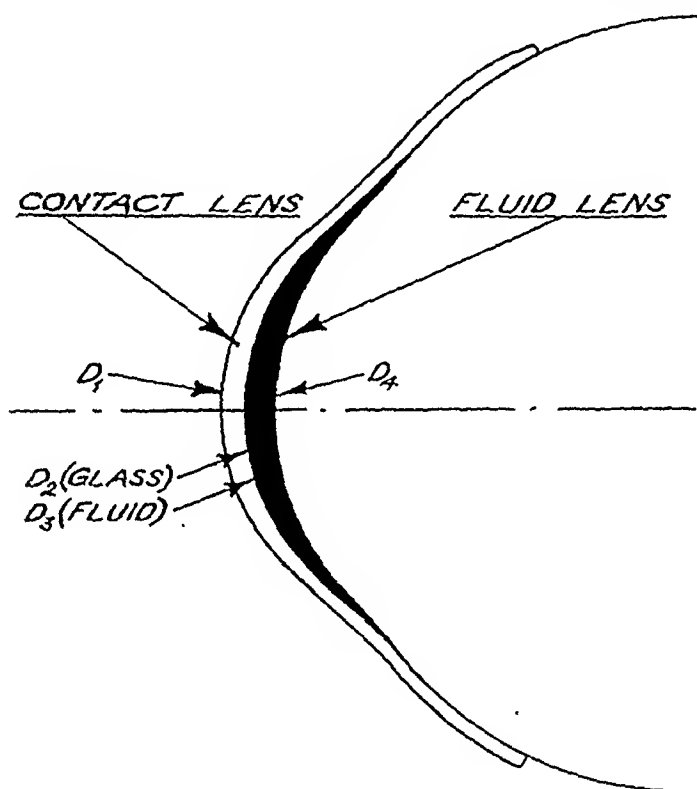


Fig. 2.—Diagram illustrating correction of an ametropic eye by a contact lens.

consider the fluid lens separated from the glass lens as well as from the cornea by an infinitely thin layer of air (Hartinger). Instead of two surfaces, D_1 and D_2 , as in the case of an ordinary spectacle lens, there will then be four surfaces, D_1 , D_2 , D_3 and D_4 .

When equation 3 is developed for an optical system of four surfaces separated by media of thicknesses t_1 , s and t_2 and of refractive indexes n_1 , 1 and n_2 , the expression A assumes the following form:³

$$A = (D_1 + D_2 - d_1 D_1 D_2) (1 - d_2 D_4) + (D_3 + D_4 - d_2 D_3 D_4) (1 - d_1 D_1) - (D_1 + D_2 - d_1 D_1 D_2) (D_3 + D_4 - d_2 D_3 D_4) s,$$

where $d_1 = \frac{t_1}{n_1}$ and $d_2 = \frac{t_2}{n_2}$.

3. Ogle, K. N.: The Correction of Aniseikonia with Ophthalmic Lenses, J. Optic. Soc. America 26:323, 1936.

Since the air space s between the contact lens and the fluid lens is zero, A reduces as shown in the formula

(12)

$$A = (D_1 + D_2 - d_1 D_1 D_2) (1 - d_2 D_4) + (D_3 + D_4 - d_2 D_3 D_4) (1 - d_1 D_1).$$

The corresponding (reduced) form of C is expressed as

(13)

$$C = -(D_1 + D_2 - d_1 D_1 D_2) d_2 + (1 - d_2 D_3) (1 - d_1 D_1).$$

The effective power, D_e , of the two lenses in succession (doublet) is therefore (compare equation 5) shown by the formula

$$D_e = \frac{A}{C} = \frac{(D_1 + D_2 - d_1 D_1 D_2) (1 - d_2 D_4) + (D_3 + D_4 - d_2 D_3 D_4) (1 - d_1 D_1)}{-(D_1 + D_2 - d_1 D_1 D_2) d_2 + (1 - d_2 D_3) (1 - d_1 D_1)}.$$

When the effective power of the glass lens is denoted by D_{e1} , that is,

$$D_{e1} = \frac{D_1 + D_2 - d_1 D_1 D_2}{1 - d_1 D_1},$$

and the effective power of the fluid lens by D_{e2} , that is,

$$D_{e2} = \frac{D_3 + D_4 - d_2 D_3 D_4}{1 - d_2 D_3},$$

D_e may be written in the form

$$\begin{aligned} D_e &= \frac{D_{e1}(1 - d_1 D_1) (1 - d_2 D_4) + D_{e2}(1 - d_2 D_3) (1 - d_1 D_1)}{D_{e1}(1 - d_1 D_1) d_2 + (1 - d_2 D_3) (1 - d_1 D_1)} \\ &= \frac{D_{e1}(1 - d_2 D_4) + D_{e2}(1 - d_2 D_3)}{-d_2 D_{e1} + (1 - d_2 D_3)}. \end{aligned}$$

According to formula 10, the following abbreviated notation may be introduced:

$$1 - d_2 D_3 = \frac{1}{S_2},$$

where S_2 represents the shape magnification of the fluid lens. Since

$$\begin{aligned} (1 - d_2 D_3) (1 - d_2 D_4) &= 1 - d_2 (D_3 + D_4 - d_2 D_3 D_4) \\ &= 1 - d_2 D_{e2} (1 - d_2 D_3) \\ &= 1 - d_2 D_{e2} \frac{1}{S_2}, \end{aligned}$$

it follows that

$$1 - d_2 D_4 = S_2 - d_2 D_{e2}.$$

Substitution of these expressions in the equation defining D_e gives

$$\begin{aligned} D_e &= \frac{D_{e1}(S_2 - d_2 D_{e2}) + D_{e2} \frac{1}{S_2}}{\frac{1}{S_2} - d_2 D_{e1}} \\ &= \frac{D_{e1} S_2^2 + D_{e2} (1 - d_2 S_2 D_{e1})}{1 - d_2 S_2 D_{e1}}, \end{aligned}$$

and finally

$$(14) \quad D_e = \frac{D_{e1} S_2^2}{1 - d_2 S_2 D_{e1}} + D_{e2}.$$

This relation shows that for a given ametropia ($D_e = \text{constant}$) there are theoretically infinitely many ways of achieving the correction.⁴

4. An ametropic eye is considered corrected when the principal focus of the corrective optical system (of effective power D_e) coincides with the far point of the eye.

In particular, it is immaterial from a dioptric point of view what the individual powers of the glass lens and the fluid lens are, as long as the sum of the two terms in formula 14 is equal to the required correction, D_e .

The simplest case arises when the glass lens is a so-called afocal or zero power lens, that is, when

$$D_{e1} = 0.$$

Then

$$D_o = D_{e2},$$

which means that the ametropia is corrected by the optical effect of the fluid lens alone.

If an afocal glass lens is used in the correction of hyperopia, the fluid lens (in analogy to spectacle lenses) is positive; if it is used in the correction of myopia, the fluid lens is negative.

Since the back surface, D_4 , of the fluid lens is determined by the cornea (the radius of which is assumed to be measurable), the front surface, D_3 , is uniquely determined by the equation

$$D_o = D_{o2} = \frac{D_3 + D_4 - d_2 D_3 D_4}{1 - d_2 D_3};$$

that is,

$$(15) \quad D_3 = \frac{D_o - D_4}{1 + d_2(D_o - D_4)}.$$

For convenience, the correspondence between the surface powers and the respective radii for $n_f = 1.336$, the assumed refractive index of the fluid lens, and for $n_g = 1.516$, the assumed refractive index of the glass lens, is given in the table. The evaluation of formula 15 for various corneal radii (r_4) and various degrees of ametropia (D_e)

Correspondence Between the Radius, the Surface Power and the Shape Magnification of Contact Lenses

Radius (r) (Mm.)	Power of Glass Surface, D. (D_s) ($n_g = 1.516$)	Power of Fluid Surface, D. (D_s) ($n_f = 1.336$)	Shape Magnification of Glass Lens	Shape Magnification of Fluid Lens
			(S_1) ($n_g = 1.516$) ($t_1 = 0.5$ Mm.)	(S_2) ($n_f = 1.336$) ($t_2 = 0.5$ Mm.)
5.0	103.20	67.20	1.035	1.026
5.5	93.82	61.09	1.032	1.023
6.0	86.00	56.00	1.029	1.021
6.5	79.38	51.69	1.027	1.020
7.0	73.71	48.00	1.025	1.018
7.5	68.80	44.80	1.023	1.017
8.0	64.50	42.00	1.022	1.016
8.5	60.71	39.53	1.020	1.015
9.0	57.33	37.33	1.019	1.014
9.5	54.32	35.37	1.018	1.013
10.0	51.60	33.60	1.017	1.013
10.5	49.14	32.00	1.017	1.012
11.0	46.91	30.55	1.016	1.011

is recorded in figure 3. The thickness of the fluid lens is assumed to vary from 0.2 mm. for lenses of high negative power to 1 mm. for lenses of high positive power. Since the radius of D_3 is equal to the radius (r_2) of the back surface of the glass lens, the results are given in terms of this radius.

The findings in figure 3 may be applied in the following ways:

(a) If D_e and r_4 are known, r_2 of the corrective afocal contact lens is determined by reading on the vertical scale the position of the intersection of the vertical line denoted by D_e with the curve denoted by r_4 .

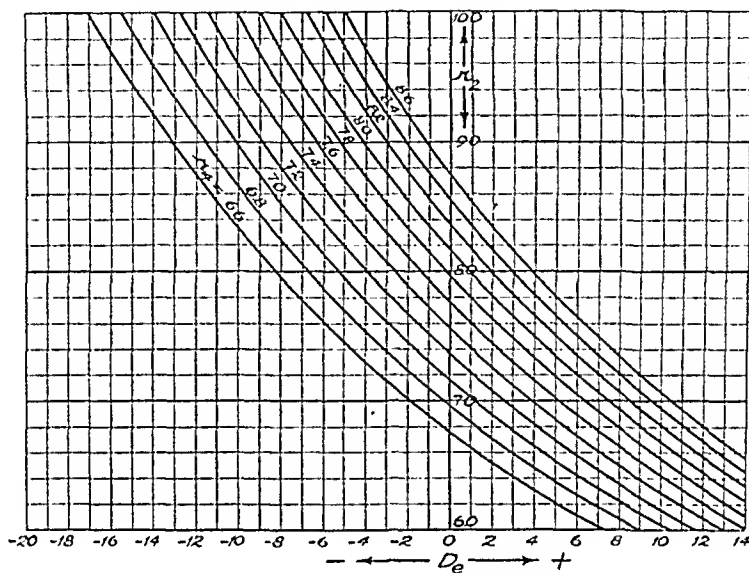


Fig. 3.—Graph showing evaluation of formula 15 for various corneal radii (r_4) and various degrees of ametropia (D_e).

Examples: Given

$$D_e = +5.00 \text{ D.}, r_4 = 7.5 \text{ mm.},$$

$$\text{then } r_2 = 6.9 \text{ mm.}$$

$$\text{Given } D_e = -15.00 \text{ D.}, r_4 = 6.8 \text{ mm.},$$

$$\text{then } r_2 = 9.85 \text{ mm.}$$

(b) If r_4 and r_2 are known, the amount of ametropia, D_e , which is corrected by the afocal contact lens is determined by reading on the horizontal scale the position of the intersection of the horizontal line denoted by r_2 with the curve denoted by r_4 . If this value for D_e differs from the required correction, the difference in power has to be supplied otherwise.

Examples:

$$r_4 = 8 \text{ mm.}, r_2 = 7.5 \text{ mm.}$$

$$(\text{Amount corrected}) D_e = 4.00 \text{ D.}$$

If the desired correction is 6.00 D., 2.00 D. has to be supplied otherwise.

$$r_4 = 7.00 \text{ mm.}, r_2 = 8.5 \text{ mm.}$$

$$(\text{Amount corrected}) D_e = -7.75 \text{ D.}$$

If the desired correction is -2.00 D, $+5.75$ D. has to be supplied otherwise.

In cases of corneal astigmatism it is immaterial for which principal meridian these calculations are made, since the results will necessarily be the same for each.

(c) If r_4 cannot be measured but full correction is achieved by an afocal contact lens of a known r_2 plus an additional spectacle power, D_{en} (referred to the cornea), the r_2' which would incorporate this D_{en} in the fluid lens is found by selecting any r_4 , determining for this r_4 and the given r_2 the corresponding D_c , and finally determining the r_2' corresponding to the correction $D_c + D_{en}$ and the same (fictitious) r_4 .

Example:

$$r_2 = 8.00 \text{ mm.}, D_{en} = -3.00 \text{ D.}$$

Choose $r_4 = 7.6 \text{ mm.}$ Then $D_c = -1.37 \text{ D.}$

For $D_c + D_{en}$ and $r_4 = 7.6 \text{ mm.}$, $r_2' = 8.6 \text{ mm.}$

In many cases the inner radius (r_2) of the contact lens is not chosen to satisfy optical considerations but is selected to insure the best possible fit. The procedure is usually this:

First, the all important problem of comfort has to be solved; then ordinary refractive methods determine what modifications have to be made optically to give full correction.

Let it be supposed that an eye wearing a contact lens requires for correction an additional power, D_{en} . If in the test this power was effective at a point h m in front of the contact lens, the power of the front surface, D_1 , of the contact lens has to be altered by the amount

$$D_{en}' = \frac{D_{en}}{1 - hD_{en}}$$

COMPARATIVE SIZE OF RETINAL IMAGES

The investigation of the comparative size of the retinal images formed in axially ametropic eyes corrected by contact lenses is carried out similarly to that shown in connection with spectacle lenses.

Again the ratio

$$\frac{I_a}{I_e} = \frac{A_o}{A'}$$

is to be considered. I_a is the retinal image formed by the corrected ametropic eye, and I_e that formed by an emmetropic eye of equivalent power, A_o . A' is the equivalent power of the combined system, the contact lens and the eye, of equivalent powers, A and A_o , respectively. Thus

$$A' = A + A_o - tAA_o.$$

The quantity t may be written

$$t = H'H_0 = H'V + VH_0,$$

where H' is the second principal point of the contact lens system, V is the vertex of the back surface, D_4 , of the fluid lens which coincides with the vertex of the cornea, and H_0 is the first principal point of the eye. For any optical system the location of the second principal point with reference to the vertex of the last surface is given by

$$VH' = \frac{C-1}{A},$$

where A and C are the constants of equation 3 derived for the given system.

If the distance VH_0 is denoted by b , t may be written in the form

$$t = -\frac{C-1}{A} + b.$$

After substitution it follows that

$$\begin{aligned} A' &= A + A_0 - \left(-\frac{C-1}{A} + b\right)AA_0 \\ &= A + A_0 + CA_0 - A_0 - bAA_0 \\ &= A + CA_0 - bAA_0, \end{aligned}$$

and since

$$\begin{aligned} A &= CD_e, \\ A' &= CD_e + CA_0 - bCD_eA_0 \\ &= C(D_e + A_0 - bD_eA_0). \end{aligned}$$

Therefore, the ratio $\frac{I_n}{I_e}$ takes the form

$$(16) \quad \frac{I_n}{I_e} = \frac{1}{C} \cdot \frac{A_0}{(D_e + A_0 - bD_eA_0)} = SP,$$

where $S = \frac{1}{C}$ is called the shape magnification of the contact lens system and

$$(17) \quad P = \frac{A_0}{D_e + A_0 - bD_eA_0}$$

may be called the power magnification of the combined system, glass lens, fluid lens and eye.

The values $A_0 = 58.64 D.$ and $b = 1.348 \text{ mm.}$ (Gullstrand) being assumed, the quantity P has been evaluated as a function of D_e (the amount of ametropia) and has been plotted in figure 4. For example, if $D_e = -10.00 D.$, $P = 1.186$, or, expressed differently, a contact lens system of $-10.00 D.$ has a power magnification of 18.6 per cent.

The term magnification is employed for the ratio of the retinal image of a corrected ametropic eye and that of an emmetropic eye.

If $D_e = +10.00 D.$, $P = 0.864$, or the power magnification is -13.6 per cent (minification).

The power magnification, P , is independent of the shape of the contact lens system; that is, it is the same for a given D_e , regardless of the particular powers and thicknesses which the glass lens and the fluid lens may have in an individual case. The total magnification is obtained by multiplying the power magnification as given in figure 4 by the shape magnification, S .

The shape magnification, S , was defined as

$$S = \frac{1}{C} = \frac{1}{-(D_1 + D_2 - d_1 D_1 D_2) d_2 + (1 - d_2 D_3) (1 - d_1 D_1)}.$$

After the substitutions

$$D_1 + D_2 - d_1 D_1 D_2 = D_{e1} (1 - d_1 D_1)$$

$$1 - d_1 D_1 = \frac{1}{S_1}$$

$$1 - d_2 D_3 = \frac{1}{S_2}$$

S takes the form

$$(18) \quad S = \frac{S_1 S_2}{1 - d_2 S_2 D_{e1}}.$$

For afocal contact lenses ($D_{e1} = 0$)

$$S = S_1 S_2.$$

An idea of the magnitude of this quantity is formed when reference is made to the table, which gives the S_1 and S_2 values for the thicknesses

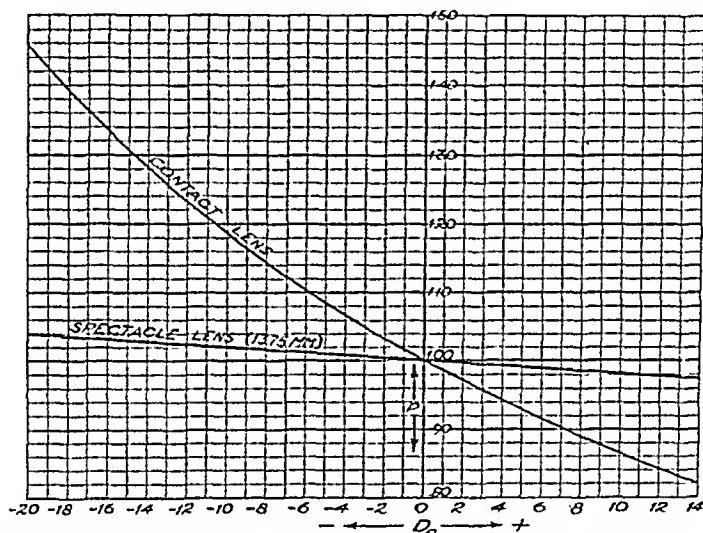


Fig. 4.—Graph showing power magnification (P) plotted against the amount of ametropia (D_c).

$t_1 = t_2 = 0.5$ mm. For instance, in order to obtain an estimate of the shape magnification produced by an afocal contact lens of an inner radius $r_2 = 7.5$ mm., 1.023, the value of S_1 for the same radius (since r_1 and r_2 of an afocal lens are approximately equal) is to be multiplied by 1.017, the value of the corresponding S_2 . The result is approximately $S = 1.04$ (the figures after the decimal point are simply added), or $S = 4$ per cent.

In the general expression for S (formula 18) sufficient accuracy will be gained by retaining only the terms of the first order among those containing d_1 and d_2 , since the values of d_1 and d_2 are always very small. Thus S may be approximately expressed in the form

$$\begin{aligned} S &= 1 + d_1 D_1 + d_2 D_3 + d_2 D_{e1} \\ &= 1 + d_1 (D_e - D_2 - D_3 - D_4) + d_2 D_3 + d_2 (D_e - D_3 - D_4) \\ &= 1 + (d_1 + d_2) (D_e - D_4) - d_1 (D_2 + D_3). \end{aligned}$$

The radius of the surface D_4 is determined by the radius of the cornea. The surfaces D_2 and D_3 are not independent of each other; by definition

$$D_2 = \frac{1 - n_g}{r_2}$$

$$D_3 = \frac{n_f - 1}{r_3}.$$

Since $r_2 = r_3$, it follows that,

$$D_2 + D_3 = \frac{n_f - n_g}{r_2} = D_{23}.$$

Therefore, approximately,

$$(19) \quad S = 1 + (d_1 + d_2) (D_6 - D_4) - d_1 D_{23}.$$

This equation is of great interest in aniseikonia, because an estimate of the possible variation in size of retinal images by means of contact lenses can be easily obtained from it. The extent of this variation, which is due solely to shape characteristics of contact lenses, will largely determine their usefulness in the correction of aniseikonia, since the power magnification is a fixed quantity dependent only on the ametropic error (D_6).

If the shape magnification which corresponds to a contact lens system when

$$t_1 = 0.5 \text{ mm.}, \quad n_g = 1.516$$

$$t_2 = 0.5 \text{ mm.}, \quad n_f = 1.336$$

$$r_2 = 8 \text{ mm.}$$

$$r_4 = 7.7 \text{ mm.}$$

$$D_6 = 0$$

is introduced as "basic" shape magnification, S of formula 19, expressed in percentage, is approximately

(20)

$$S \% = 3.81 + 0.44 \Delta t_1 + 0.33 \Delta t_2 - 0.01 \Delta r_2 - 0.04 \Delta r_4 + 0.07 D_6.$$

In this equation the constant 3.81 per cent is the basic magnification; Δt_1 , Δt_2 , Δr_2 and Δr_4 are the increments of the indicated quantities. They are to be expressed in tenths of a millimeter and are positive when the given quantities are larger than those chosen for the basic magnification; they are negative when the given quantities are smaller. For instance, if t_1 is 0.1 mm. larger than 0.5 mm. ($\Delta t_1 = 1$), the magnification is 0.44 per cent larger; if t_2 is 0.1 mm. smaller than 0.5 mm. ($\Delta t_2 = -1$), the magnification is 0.33 per cent smaller. Thus, the shape magnification for a contact lens system when

$$t_1 = 0.7 \text{ mm.}$$

$$t_2 = 0.3 \text{ mm.}$$

$$r_2 = 7.5 \text{ mm.}$$

$$r_4 = 7.5 \text{ mm.}$$

$$D_6 = +4.00 \text{ D.}$$

is approximately

$$S \% = 3.81 + 0.44 \times 2 + 0.33 \times (-2) - 0.01 \times (-5) - 0.04 \times (-2) + 0.07 \times 4 = 4.44.$$

Equation 20 shows that of those quantities which (in certain limits) may be chosen arbitrarily, namely, t_1 , t_2 and r_2 , only changes of t_1 and t_2 can affect the magnification appreciably.

Let it be assumed that a test for aniseikonia is made after the dioptric condition of a patient has been fully corrected by means of contact lenses. Always under the hypothesis that the required thicknesses (say, from $t_1 + t_2 = 0.6$ mm. up to $t_1 + t_2 = 2$ mm.) are physically possible, can be tolerated by the eye and are adequately controllable in the process of fitting, it can be said that in extremely favorable cases iseikonic differences up to 5 per cent can be corrected by changing the shape qualities of contact lenses. If, instead of 2 mm., 1 mm. is considered as the maximum tolerance for $t_1 + t_2$, the figure drops to only about 1.5 per cent.

It seems, therefore, that the significance of contact lenses as a corrective means in aniseikonia does not rest so much on the variability of magnification due to changes in thickness but is evident in those favorable cases in which the power magnification and the basic shape magnification can be used to equalize otherwise existing differences in size.

It is to be noted, however, that a remarkable variability of magnification is available when spectacle lenses are used in combination with contact lenses. The reason for this is to be found in the fact that the power magnification of contact lenses changes much more rapidly with D_o than the power magnification of single lenses (fig. 4⁵). For instance, in order to increase the magnification of an emmetropic eye, it can be made artificially hyperopic by means of a contact lens of negative D_o which will increase the magnification of the combined system (the contact lens and the eye). Then, while the error in power can be offset by an ordinary spectacle lens, the increase of magnification cannot be offset completely. There will remain a residual magnification, which is, of course, the magnification of the small galilean telescope consisting of the positive spectacle lens and the negative contact lens system. The index c being used for all quantities referring to the contact lens and the index s for those referring to the spectacle lens, the telescopic magnification is given by the formula

$$M = -\frac{A_c}{A_s} = -\frac{D_{ec}S_s}{D_{es}S_c}.$$

If the power D_{es} of the spectacle lens is effective at h m. in front of the contact lens, D_{ec} is approximately ⁶ given by

$$D_{ec} = \frac{-S_c^2 D_{es}}{1 - h D_{es}}.$$

5. The D_o' of the spectacle lens at h m. from the cornea, is, of course, different from the D_o of the contact lens correcting the same ametropic error. The two powers are related by

$$D_o = \frac{D_o'}{1 + h D_o'}.$$

6. If the glass lens is afocal, the exact expression is

$$D_{ec} = \frac{-S_c^2 D_{es}}{1 - D_{es} (h + S_1 d_1 + S_1^2 S_2 d_2)}.$$

Therefore, the telescopic magnification may be expressed approximately in the form

$$(21) \quad M = S_e S_s \left(\frac{1}{1 - h D_{es}} \right).$$

According to this formula, the telescopic magnification for $D_{es} = +8.00$ D., $h = 0.013$ m., $S_e = 1.04$, and $S_s = 1.03$ is approximately 1.2, or 20 per cent.

A good example of these methods of changing differences in size is the important case of monocular aphakia.

An aphakic eye assumed to be normal in all other respects has a total power of 43.00 D. Its first principal point can be assumed to coincide with the vertex of the cornea. If such an eye is corrected by an ordinary spectacle lens, the retinal image is about 25 per cent larger than that for an emmetropic eye (the shape and position of the lens being conditional factors). If the other eye is assumed to be emmetropic, the difference of 25 per cent in the size of the retinal image, in general, is a deciding factor in making single binocular vision impossible. In the event that the aphakic eye is corrected by a contact lens of power $D_e = 11.75$ D., the retinal image of the aphakic eye compared to that of the emmetropic eye is (according to equation 16)

$$\frac{I_a}{I_e} = S \cdot \frac{A_o}{D_e + A_a - b D_e A_a},$$

where

$$A_o = 58.64 \text{ D.}$$

$$A_a = 43.00 \text{ D.}$$

$$b = 0.$$

It follows that

$$\frac{I_a}{I_e} = S \cdot 1.071.$$

If S is 1.04, the total difference in size expressed in percentage is 11.40. The reduction of the magnification from 25 to 11.4 per cent is due to the power magnification (minification) of the contact lens. In order partially to wipe out this remaining difference, a contact lens of power $D_e = 0$ could be worn on the emmetropic eye the basic shape magnification (about 4 per cent) of which should be increased as much as is tolerated by the eye by choosing a large thickness for t_1 or t_2 or for both. Thus, in a favorable case, the difference in size of the retinal images may be reduced to only about 6 per cent.

If, however, spectacle lenses are used in addition to contact lenses, the difference in size of 11.4 per cent which remains after the correction of the aphakic eye by a contact lens (plus the shape magnification of the zero power spectacle lens in front of the aphakic eye) can be easily wiped out according to formula 21, if the emmetropic eye is made about 3 D. hyperopic by a contact lens and is then corrected with an ordinary spectacle lens.

ADIE'S SYNDROME

REPORT OF CASES

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Sir William Osler many years ago characterized syphilis as "the great imitator" because it can simulate or complicate nearly every condition known in the field of internal medicine. The converse of Dr. Osler's statement is that many of the conditions known in the field of internal medicine can simulate syphilis. But while the original dictum has become a familiar part of medical training, its logical converse has received little attention.

It is our purpose in this paper to draw attention to a symptom complex which has repeatedly been mistaken for syphilis of the central nervous system. Many unfortunate persons presenting it have been treated for *tabes dorsalis*, and in some instances it has played a major role in disrupting family life and leading to a vast amount of unnecessary anxiety and misery. Ordinarily it presents a rather simple picture, consisting merely in tonic reactions of one or both pupils and in the absence of some or all of the deep tendon reflexes.

The myotonic pupillary reaction was first described in 1902 by Saenger¹ and Strasburger,² reporting independently. Markus³ in 1905 reported before the British Ophthalmological Society a case in which the patient showed a myotonic pupil with absence of the knee jerks and ankle jerks. In 1931, under the title "Pseudo-Argyll Robertson Pupils with Absent Tendon Reflexes: A Benign Disorder Simulat-

Read before the New York Academy of Medicine, Section of Ophthalmology, Oct. 18, 1937.

From the Neurological Service, the Bellevue Hospital, and the Neuropsychiatric Service, the United States Marine Hospital, Ellis Island.

1. Saenger, A.: Ueber myotonische Pupillenbewegung, *Neurol. Centralbl.* **21**:837, 1902.

2. Strasburger, J.: Pupillenträgheit bei Akkomodation und Convergenz, *Neurol. Centralbl.* **21**:1388 and 1052, 1902.

3. Markus, C.: Notes on a Peculiar Pupil Phenomenon in Cases of Partial Iridoplegia, *Tr. Ophth. Soc. U. Kingdom* **26**:50, 1906.

ing *Tabes Dorsalis*" Adie⁴ reported a study of six persons. In all his cases one or both pupils showed either very poor reaction to light or none at all, and a tonic slow reaction on convergence, with even slower subsequent dilatation. There was also some loss of deep tendon reflexes in all the cases. The presence of syphilis was ruled out in each person, and no other neurologic signs were noted. The following year R. Foster Moore⁵ and Gordon Holmes⁶ presented similar cases before the Ophthalmological Society of the United Kingdom. Moore,⁷ as a matter of fact, had presented such cases before the society in 1924, but his neurologic data were incomplete.

In 1932 Adie⁸ again presented his material, to which he had added much in the meantime, and characterized the syndrome as "a benign disorder *sui generis*." He was able at this time to report nineteen cases of his own, in thirteen of which tendon reflexes were absent and in six of which only pupillary changes were seen. He also collected and reviewed forty-five published cases, in nine of which tendon reflexes were absent. Many of Adie's patients had been followed over a period of years, without any evidence of syphilis or any additions to the neurologic picture.

Weber⁹ in 1933 was able to reexamine Markus'³ patient with a "myotonic" pupil after an interval of twenty-seven years. The patient still had a tonic right pupil, smaller than at the time of the original report; the patellar and achilles reflexes were still absent. The subject was entirely well, was working, was married and had two healthy children. The blood serum gave negative Wassermann and Meinicke reactions. No similar pupillary phenomena had been discovered among his relatives. Other patients have also been followed for long periods, with similar findings.¹⁰ Rudolf¹¹ reported the syndrome occurring in a

4. Adie, W. G.: Pseudo-Argyll Robertson Pupils with Absent Tendon Reflexes: A Benign Disorder Simulating *Tabes Dorsalis*, *Brit. M. J.* **1**:928, 1931.

5. Moore, R. F.: The Non-Luetic Argyll-Robertson Pupil, *Tr. Ophth. Soc. U. Kingdom* **51**:203, 1932.

6. Holmes, G.: Partial Iridoplegia Associated with Symptoms of Other Diseases of the Nervous System, *Tr. Ophth. Soc. U. Kingdom* **51**:209, 1932.

7. Moore, R. F.: Physiology and Pathology of Pupil Reactions, *Tr. Ophth. Soc. U. Kingdom* **44**:38, 1924.

8. Adie, W. J.: Complete and Incomplete Forms of the Benign Disorder Characterized by Tonic Pupils and Absent Tendon Reflexes, *Brit. J. Ophth.* **16**:449, 1932.

9. Weber, F. P.: Report on Dr. Markus's Original Case, *Proc. Roy. Soc. Med.* **26**:530, 1933.

10. Barré, J. A., and Klein, M.: Adie Syndrome Case, *Rev. neurol.* **1**:590, 1934.

11. Rudolf, G. de M.: Tonic Pupils with Absent Tendon Reflexes in Mother and Daughter, *J. Neurol. & Psychopath.* **16**:367, 1936.

mother and her daughter. The tonic pupillary reaction had been present in the mother for a period of thirty-two years. Such patients, followed over a period of years, offer presumptive evidence that the syndrome described by Adie is benign.

The syndrome may be present in a complete or an incomplete form. The complete form is regarded as that in which one or both pupils fail to react normally to light and have a tonic convergence reaction and in which there is absence of one or more deep tendon reflexes. The incomplete form may consist of: (a) tonic pupillary reactions alone, (b) atypical phases of tonic pupillary reactions alone, (c) atypical pupils with absence of tendon reflexes and (d) absence of tendon reflexes alone.

Of major importance in recognizing the syndrome is the differential diagnosis between the Argyll Robertson pupil and the tonic or myotonic pupil. The disorder of the pupil described by Argyll Robertson¹² has the following characteristics: (a) the pupil is miotic; (b) the condition is bilateral; (c) the accommodation or the convergence reaction is normal or overactive; (d) the pupil is fixed to light, and (e) it reacts poorly to mydriatics.

The tonic or myotonic pupil, on the other hand, presents the following characteristics: (a) The condition is unilateral in 80 per cent of cases. (b) The affected pupil is usually larger than its fellow; that is, the pupils are unequal. (c) During accommodation, after a short delay, the pupil contracts to a degree often greatly in excess of normal. It may then remain small for several minutes after the act of convergence has ceased, after which dilatation proceeds at a much slower rate than contraction. (d) The direct and consensual reactions to light, as ordinarily tested, are completely or almost completely abolished. However, after the subject has been in a dark room the pupil *does* dilate, and on subsequent exposure to daylight contracts very slowly again. Contraction may proceed until the pupil becomes considerably smaller than it was before dilatation in the dark room. Then it again dilates very slowly to its original size. The reaction to bright light after dilatation may take several minutes. (e) The pupil reacts normally and completely to mydriatics.

We now report the following cases:

REPORT OF CASES

CASE 1.—H. G., a single white American man, was admitted to the State Psychopathic Hospital at the University of Michigan on March 25, 1932. He came to the clinic because of a state of chronic anxiety, pains in his head, and

12. Merritt, H. H., and Moore, M.: The Argyll Robertson Pupil, *Arch. Neurol. & Psychiat.* 30:357 (Aug.) 1933.

multiple phobias, especially the fear of insanity. There was also evidence of latent homosexuality. His illness consisted of a set of phobias rooted in this homosexuality and of a state of chronic anxiety with periodic outbursts of acute panic, which rested, in turn, on the phobias.

Physical examination gave entirely normal findings except that the right pupil was larger than the left and each reacted fairly well to light but very poorly in accommodation. The knee jerks and ankle jerks were absent. There was vasomotor instability, with constantly changing mottled cutaneous patterns and marked dermatographia. These serologic reactions of the blood and spinal fluid were normal, as were the results of all the other laboratory tests. The patient returned to the clinic one year later, at which time the right pupil was still larger than the left. Both reacted very sluggishly to light but were especially tonic in their reaction to accommodation, taking over sixty seconds to reach their full degree of contraction. Then, in a darkened room, they dilated even more slowly, requiring one hundred and twenty seconds to reach the peak of their dilatation.

The patient's mental state was by now much improved. He was therefore discharged.

In summary, a 20 year old single man entered the hospital for a state of chronic anxiety. Subsequent psychiatric examination revealed marked evidence of latent homosexuality. Physical examination revealed definite evidence of Adie's syndrome in the nature of a tonic right pupil and absence of deep reflexes in the lower extremities. It is of interest that the reactivity of the pupil varied with the patient's emotional state. Syphilis was suspected as the organic cause in this case until the appearance of Adie's paper made apparent the benign nature of this patient's condition.

CASE 2.—J. B., a 28 year old single man of Jewish extraction, was admitted to the Bellevue Hospital on Nov. 5, 1932, because he complained of blurred vision and a large left pupil, which he stated had followed the draining of both maxillary sinuses in June 1932. He recalled, however, that twelve years previously his roommate (a premedical student) had been unable to obtain any knee jerks from him. The past history and family history were irrelevant except that the patient's mother had died in 1931 after becoming mentally deranged.

The patient was exceedingly well developed. Physical examination showed no abnormality except that the left pupil was enlarged and fixed to light and in accommodation. There was also no consensual reaction from left to right. In addition, the knee jerks and ankle jerks were not obtainable. Psychiatric examination revealed that this patient was suffering from a severe anxiety neurosis, and Dr. Aaron Bell, who has followed the patient since his discharge, stated that he has had recurrent attacks of acute homosexual panic.

The patient was again seen on June 24, 1936. On this occasion the left pupil was smaller than the right and still fixed to light and in accommodation, with loss of consensual reaction from left to right. The knee jerks and ankle jerks were still absent. There was no longer blurring of vision. The patient spontaneously made the following remark: "This pupil is the best indication of my personality that I know. When I'm excited you can't see any color in my

eye; when I'm calm the pupil is small, as it is now, and it will sometimes show a slight reaction to light." Three weeks previously the patient had another Wassermann test of the blood made because "Every doctor I see insists I have at least ten plus syphilis."

In summary, a 28 year old unmarried Jewish-American man who entered the hospital complaining of blurred vision presented a typical Adie's syndrome (incomplete) in the nature of a large, fixed left pupil and absence of deep reflexes in the lower extremities. A psychiatric survey revealed that the patient had an anxiety neurosis with marked evidence of latent homosexuality. In this case, too, there was evidence that the emotional state of the patient affected the size and reactivity of the left pupil. In this case, again, syphilis had been suggested to the patient as an etiologic factor by so many physicians that he had a definite syphilophobia.

CASE 3.¹³—M. McC., an Irish woman aged 33, was admitted to the United States Marine Hospital at Ellis Island because a previous examination had revealed "a fixed left pupil and absent patellar and achilles reflexes."

She would admit to no complaints—a common occurrence in immigrants who are anxious to enter this country. She did, however, state that the left pupil had been smaller than the right since birth. She denied having had defective vision at any time.

General physical examination gave entirely normal findings. The blood pressure was 145 systolic and 90 diastolic on admission, but varied a good deal.

Neurologic examination showed unequal pupils, the left being smaller than the right. The right pupil reacted to light and in accommodation; the left reacted to neither and showed definite hippus. All the deep reflexes were absent and could not be obtained with reinforcement. The Wassermann reactions of the blood and spinal fluid were negative. Chemical studies and studies of the blood showed no abnormality.

Since the patient did not stay at the hospital for any length of time, no complete psychiatric survey could be made, nor could we judge the effect of emotion on the condition.

In summary, a 33 year old unmarried Irish immigrant woman with no complaints was sent to the United States Public Health Service for further check-up because syphilis was suspected. Examination revealed that her condition corresponded to the third incomplete type of Adie's syndrome, that is, atypical pupils with absence of deep reflexes. There was also some evidence of autonomic imbalance in the form of moist extremities and a relatively labile blood pressure.

CASE 4.—I. A., a 37 year old Jewish-American man, was seen in private practice on April 7, 1937. He had no complaints but had been unable to obtain insurance for ten years because he was told that he "probably had burned-out

13. This case was previously reported by S. B. Wortis and J. D. Reichard: Adie's Syndrome, *Hosp. News* 2:14, 1935.

tabes." In addition, he had delayed marrying the woman of his choice for seven years because he was afraid of the consequences. He had had nineteen Wassermann tests of the blood and one Wassermann test of the spinal fluid, which were negative. Despite this, no physician was willing to assure him that he did not have syphilis, and he had already undergone several modified therapeutic regimens.

Physical examination gave entirely normal findings except that both pupils were large, slightly irregular and absolutely fixed to light and in accommodation. They did, however, dilate very promptly after mydriatics were used. All the deep reflexes were absent. Neurologic examination otherwise showed no abnormality. After several hours in a dark room the pupils reacted sluggishly to light and after a prolonged latent period showed a good reaction in accommodation. The Wassermann reactions of the blood and spinal fluid were negative. We have had no opportunity to follow this patient. A sister and two brothers were examined; no evidence of Adie's syndrome was found in any of them.

In summary, a 37 year old Jewish-American man sought medical advice because he had been repeatedly told that he had syphilis. Examination revealed that the patient had a typical Adie's syndrome, with tonic pupils, absence of deep reflexes and negative serologic reactions. Since receiving our assurance that he had a benign condition he has made plans to marry.

CASE 5.—E. T., a 28 year old American housewife, was seen in private practice on April 28, 1937. She complained of severe occipital headache, which was persistent and which on occasion migrated over the vertex of the skull. This headache had been present for eighteen months. Four months before she was seen by us her local physician told her that she had a rigid right pupil and gave her a course of injections of tryparsamide. Another physician had told the husband that his wife had either latent syphilis or a tumor of the brain.

Physical examination gave entirely negative results except that the right pupil was seen to be irregular, larger than the left, completely fixed to light and showing a definite tonic reaction in accommodation. The knee jerks and ankle jerks were absent, even with reenforcement. The right iris showed atrophy of the pigmented borders in the lower and outer quadrants. The husband was a coarse, difficult person, and it was felt that the patient's headache might well be a reaction against a troublesome situation in the home. The Wassermann reactions of the blood and spinal fluid were normal.

The patient was extremely tense, anxious and demanding of attention throughout her stay in the hospital.

The tonic reaction in accommodation persisted, but it was noted that at periods when the patient was not tense a definite reaction to light could be obtained in the right pupil and the reflexes in the lower extremities were readily obtained with reenforcement. The husband refused to accept the fact that no organic cause for his wife's headache was demonstrable and took her home against advice.

In summary, a 28 year old American housewife sought medical advice because of intractable headache of eighteen months' duration. In addition, she had been told previously that she had a rigid right pupil.

Examination revealed that the patient had a typical Adie's syndrome, with a tonic right pupil and absence of deep reflexes in the lower extremities. The serologic reactions were entirely normal. The reaction of the right pupil to light and the presence or absence of deep reflexes in the lower extremities varied according to the patient's emotional state.

COMMENT

In general,¹⁴ the syndrome has been found in healthy young females without other signs of organic nervous disease. It is generally symptomless except for a not uncommon photophobia on passing from a dark to a light place. The ratio as to sex is approximately 5 females to 1 male. Many of the patients give evidence that the ocular signs have been present since childhood; they have lived many years without the appearance of any other signs or symptoms. In thirty-seven of Adie's cases the blood and spinal fluid were examined by the Wassermann test for evidence of syphilis; in eighteen the blood only was examined; all the reactions were negative.

Adie's use of the phrase a benign disorder sui generis has occasioned some discussion. Jelliffe¹⁵ reported having found the syndrome in cases of influenza, encephalitis, diabetes and alcoholic polyneuritis and also described its occurrence in "dysthyroid states." It has also been

14. (a) Hassin, G. B., and Thompson, J. J.: Pupillotonia or Tonic Pupils, *J. Nerv. & Ment. Dis.* **80**:430, 1934. (b) Coppez, H.: Adie's Syndrome, *Bull. Soc. belge d'opht.* **70**:60, 1935. (c) Harvier, P., and Boudin, G.: Adie Syndrome in Syphilitic Retinochoroiditis, *Paris méd.* **1**:177, 1935. (d) Muller, H. K.: Pupillotonia and Absent Tendon Reflexes, *Ztschr. f. Augenl.* **88**:20, 1935. (e) Thomas, A., and de Ajuriaguerra, J.: Association of Pupillary Disturbances and of Osteotendinosa Areflexia with Discussion of Adie Syndrome, *Rev. neurol.* **66**:78, 1936. (f) Barré, J. A., and Helle: Adie Syndrome with Bilateral Pupillary Disturbance, *ibid.* **1**:542, 1934. (g) Bramwell, E.: Holmes-Adie Syndrome, *Tr. Med.-Chir. Soc. Edinburgh*, 1935-1936, p. 83. (h) de Busscher, J.: Pupillotonia and Areflexia of Tendons, *J. belge de neurol. et de psychiat.* **35**:331, 1935. (i) Petit, J.: Adie Syndrome, *Helvet. med. acta* **3**:238, 1936. (j) Brouwer, B.: Pupillotonia Associated with Areflexia of the Extremities, *Nederl. tijdschr. v. geneesk.* **77**:4880, 1933. (k) Schneider, M.: Absent Tendon Reflexes and Tonic Pupils, *M. J. Australia* **1**:153, 1933. (l) Cardona, F.: Adie Syndrome, *Riv. di pat. nerv.* **48**:188, 1936. (m) Subirana, A.: Adie Syndrome, Abolition of Tendon Reflex and Simulation of Argyll Robertson Sign, *Arch. de neurobiol.* **15**:93, 1935. (n) Hubin, R.: Adie Syndrome, *Liège méd.* **29**:605, 1936. (o) Chavany, J. A.: Adie Syndrome, *Presse méd.* **43**:1243, 1935. (p) Adie, W. G.: Tonic Pupils and Absent Tendon Reflexes, *Brain* **55**:98, 1932.

15. Jelliffe, S. E.: Hypothyroidism and Tabes Dorsalis, *New York State J. Med.* **31**:363, 1931; The Myotonic Pupil: Contribution and Critical Review, *J. Neurol. & Psychopath.* **13**:349, 1933.

noted in association with various sympathetic disorders,¹⁶ in various types of psychopathy¹⁷ and even in association with pernicious anemia.¹⁸

All the aforementioned associations with various diseased conditions have tended to throw doubt on Adie's conception of "a benign disorder, *sui generis*." The hard fact remains, however, that many cases have been observed carefully in healthy people and over long periods without discovery of any associated organic disease. From a practical standpoint, it seems of little importance whether the syndrome is a disorder *sui generis* or not. It is, at the very least, a complex of signs of sufficient constancy and of frequent enough occurrence to make it a handy and a necessary tool of differential diagnosis. Adie restricted the syndrome to those cases in which there are no other neurologic signs and to persons who are otherwise in good health. In the interests of diagnostic clarity, it seems logical to follow these restrictions. To report the syndrome in association with every sort of disease is to widen its significance progressively until it loses all meaning and value—a procedure which Adie manifestly never intended.

However, vasomotor instability is also frequently noted in patients presenting this syndrome. Franchel¹⁶ and Harvier and Boudin^{14c} reported cases of this condition in which the oculocardiac reflex was absent on one or both sides, and the latter authors spoke of an "unsteady" pulse in connection with their case.

The most interesting question raised by all these observations is, of course, What does a combination of pupillotonia and absence of tendon jerks mean in terms of anatomy, pathology, psychology and physiology? Indeed, why should the two disorders be associated at all? Is there a common etiologic factor in all these cases?

These are difficult questions about which there has been a good deal of theorizing. Some of these theories may be briefly stated. Throughout the French literature there runs a tone of suspicion that in spite of the absence of all clinical findings the syndrome may be due to a form of syphilis which the French writers have called latent. Accordingly, several of them have treated the recognized syndrome with anti-syphilitic measures, but without success. Franchel suggested that the syndrome may be a disorder of the vegetative nervous system, a con-

16. Franchel, F.: Tonic Pupils (Adie Syndrome), *Gaz. d. hôp.* **108**:1665, 1935.

17. Petit, G., and Delmond, J.: Adie Syndrome in Mental Pathology, *Ann. méd.-psychol.* **94**:497, 1936. Parker, S.; Schilder, P., and Wortis, H.: A Specific Motility Psychosis in Alcoholic Negroes, *Arch. Neurol. & Psychiat.*, to be published. Bromberg, W.: Atypical Case of Syndrome of Tonic Pupils and Absence of Reflexes, *ibid.* **33**:676 (March) 1935.

18. Petit, G., and Delmond, J.: Adie Syndrome and Polyneuritic Psychosis in Pernicious Anemia, *Ann. méd.-psychol.* **94**:106, 1936; Transitory Adie Syndrome, Pernicious Anemia and Latent Parkinsonism in Course of Subacute Mental Confusion, *ibid.* **94**:236, 1936.

genital myotonia accompanied with a muscular lesion in the iris, or due to a lesion of the ciliary ganglion. Adie agreed with Franchel's first suggestion.

It may be clearly seen, then, that at the present time ideas as to the possible etiology are very hazy. Jelliffe in 1921 reached the conclusion that psychogenic factors could cause the picture of Adie's syndrome—but thought that this was done indirectly through an effect on thyroid function. Petit and Delmond found the syndrome in patients with diverse mental troubles, often in association with endocrine and vasomotor difficulties. They suggested the infundibulum as a possible seat of pathologic changes.

In connection with the discussion of this seeming relationship between emotion and Adie's syndrome, the salient features of a case presented by Inman¹⁹ in 1925 are of interest.

A lady, aged 32, consulted me in 1915 and again in 1916 on account of some difficulty in reading. Beyond a low degree of compound hypermetropic astigmatism, nothing abnormal was found. In May 1921, she attended again complaining of headache. The left pupil was found to be larger than the right and to react to accommodation but not to light. The Wassermann reaction was negative. As she was of the type commonly described as "high strung" I surmised that some shock or grief might have caused the symptom and asked her if she had had any recent bereavement. To my astonishment, she burst into tears and told me of the death of her father, which had occurred, not immediately before, as one might have supposed, but 14 months previously in March 1920. On the anniversary of his death she was on her way to visit his grave and was actually buying a wreath when her sister noticed and commented on the dilatation of her left pupil which was so pronounced as to give her a strange look. I saw her again in March 1922. She was then unaware that it was about the time of the second anniversary of her father's death. The pupils were at first normal in size and reaction but a reference on my part to the old sorrow, whilst evoking no apparent emotion, was yet followed by a dilatation of the left pupil.

It is therefore clear that the combination of Adie's syndrome with emotional disturbances and vasomotor lability is a not uncommon one.

When one searches for some anatomic mechanism which mediates impulses concerned in this triad of conditions, the hypothalamus becomes suspect. It is realized that the idea of relegating any new functions to any area which seems already overloaded with them is one which may not easily be accepted. Evidence²⁰ has been presented to confirm the

19. Inman, J.: The Non-Luetic Argyll Robertson Pupil, *Brit. M. J.* **2**:1170, 1925.

20. Ranson, S. W., and Magoun, H. W.: Respiratory and Pupillary Reactions Induced by Electrical Stimulation of the Hypothalamus, *Arch. Neurol. & Psychiat.* **29**:1179 (June) 1933. Karplus, J. P., and Kreidl, A.: Gehirn und sympathicus: I. Zwischenhirnbasis und Halssympathicus, *Arch. f. d. ges. Physiol.* **129**:138, 1909;

fact that in the hypothalamus closely associated nuclear masses have a large degree of control over pupillary reactions, vasomotor changes and emotional responses. The connections of the hypothalamus with the frontal lobes, the olfactory system, the thalamus, the spinal cord and the pituitary gland provide the anatomic basis for a wide field of influence.

Before closing we wish to emphasize that these cases are presented not so much as an exercise in speculative pathology as to stress the fact that Adie's syndrome is a symptom complex which closely simulates syphilis of the nervous system and is *not* syphilis. We believe that a knowledge of the syndrome is, or should be, an indispensable part of the mental furniture of every physician who undertakes to diagnose syphilis of the central nervous system.

DISCUSSION

DR. FOSTER KENNEDY: An attempt to interpret the signs reported in this paper is really an exercise in speculative pathology. The Argyll Robertson pupil is not merely a syphilitic pupil. It can be found in cases of epidemic encephalitis, and it has been described by men of the highest competence as having occurred in association with multiple sclerosis. I have never seen such a case, but if Kinnier Wilson says that he has, I am sure it is a fact.

I had occasion at the old Neurological Institute on Sixty-Seventh Street to observe a young boy with tumor in the left temporosphenoid region. The tumor was mesially placed and therefore impinged closely on the quadrigeminal bodies. The course followed the progression of tumors of the brain in general in that there were periods when there was increased edema around the tumor. When increased edema and increased intracranial pressure were present, the boy would have severe headaches and acute attacks of vomiting, and signs referable to the quadrigeminal bodies would appear; that is, the child would lose his ability to move his eyes upward and conjugately. At the same time that he lost the ability of conjugate movement of the eyes upward, Argyll Robertson pupils would develop, which would not react to light but still be able to react in accommodation. When the crisis was over, a matter of only a few hours, the pupils returned to normal. Eventually the tumor encroached on the midbrain sufficiently to fix the eyes in mid-position, and by this time the pupils were fixed permanently.

Gehirn und Sympathicus: II. Mitteilung, ein Sympathicuszentrum in Zwischenhirn, *ibid.* **135**:401, 1910; Gehirn und sympathicus: III. Sympathicusleitung in Gehirn und Halsmark, *ibid.* **143**:109, 1912; Ueber experimentelle reflektorische Pupillenstarre, *Neurol. Centralbl.* **32**:82, 1913. Ingram, W. R.; Ranson, S. W.; Hannett, F. I.; Zeiss, F. R., and Terwilliger, E. H.: Results of Stimulation of the Tegmentum with the Horsley-Clark Stereotaxic Apparatus, *Arch. Neurol. & Psychiat.* **28**:513 (Sept.) 1932. Ranson, S. W., and Magoun, H. W.: The Central Path of the Pupilloconstrictor Reflex in Response to Light, *ibid.* **30**:1193 (Dec.) 1933. Langworthy, O. R., and Tauber, E. S.: The Control of the Pupillary Reaction by the Central Nervous System, *J. Nerv. & Ment. Dis.* **86**:462, 1937.

In this case, then, I saw the Argyll Robertson pupil develop and I saw it disappear; I watched this transformation for at least five times. Cases such as this show that one cannot be certain that this phenomenon is purely syphilitic, as it has been described. It is usually syphilitic in origin. Such a pupil must always make one think of syphilis, but it has been described by good observers as occurring even in traumatic conditions affecting the mesencephalon.

There is certainly a physiologic differential in the pathways of the visual functions and the pupillomotor fibers. It is probable that the pupillomotor fibers pass from the superior colliculi subependymally in the gray matter of the aqueduct, just below the gray matter of the aqueduct, toward the third nucleus, and it is quite probable that they never reach the third nucleus. They probably go below the third nucleus and pass, with the fibers coming from the third nucleus, to the ciliary ganglion. It has been commonly said that the tonic pupils we spoke of are due to a lesion of the ciliary ganglion, but this is simply because of an unthoughtful acceptance of the old theory that the Argyll Robertson pupil was due to a lesion of this ganglion. The ciliary ganglion is normal in the vast majority of cases of tabes. I think that it is occasionally abnormal as a secondary result of the destruction of these pupillomotor fibers in the subependyma producing a secondary degeneration of the ciliary ganglion. The main lesion is almost certainly located in the neighborhood of the floor of the aqueduct. Why does this cause the knee jerks to disappear? What has it to do with the knee jerks? It is not known for sure, but certain tonic centers do exist in the periaqueductal area; the area for general muscle tonus is influenced by centers in the neighborhood of the floor of the aqueduct, the exact nature of which is not understood, though lesions here are often associated with complete disappearance of deep reflexes from altered tonus. It is common in cases of midline tumor of the cerebellum, in which the aqueduct is enormously dilated and in which the ependyma of the aqueduct is under compression, to find that the knee jerks have disappeared. Why this phenomenon should be associated with abnormal emotional states, as it seems to be, is again speculative. Of course, if a person in whom this sign is present did not have something the matter with him he would not see a physician. And when he does, it is probably easy for the physician to associate his complaints (and most complaints are emotional, after all) with the peculiar anatomic condition which is found. On the other hand, the hypothalamus is the governing center for one's emotional make-up. Changes in the hypothalamus can make a pessimist out of an optimist or an optimist out of a pessimist, and it is perfectly possible that tense emotions will interfere with proper conduction of fibers! That reminds me of a conversation I had once with Michael Pupin, who asked me if doctors had found the place in the brain that governs emotion, and to his surprise I said "yes." He said, "That is very interesting; where is it?" So I answered, "In the hypothalamus." "Ah," he said, "I did not know that, but can you pull the switch?" I said, "No, we cannot pull the switch yet, but when we can all the governments of the earth will arrange for a great switching day at the switching posts, and everybody will be willing to be switched into happiness. There will be one man in every two hundred

million who will hang back, and six months after the switching day those men who would not be switched into contentment will find that they are lords of the world; and six months after they have become lords of the world, they will find that there is no world to become lords of, that they are merely shepherds of sheep. Nobody will work, so the lords of the world, in order to make humanity unhappy and miserable and therefore ambitious and ready to work, will gather up all the doctors, load them onto scows and tow them into the Atlantic Ocean and sink them! So, if the medical profession found out too much about the hypothalamus, and if it really found out why persons with a lesion in this region have no reflexes, it might risk destroying itself, and therefore it has taken care to fail."

DR. JOHN H. DUNNINGTON: I am sure that the syndrome reported has been overlooked many times. The point which seems to me to be of particular value, and which possibly has not been stressed enough, is the ease with which the pupils of a person with this condition dilate with the use of a mydriatic. I have found this sign to be of help in arriving at a diagnosis. Also, the fact that they dilate after long exposure in a dark room and contract slowly is another point.

DR. JOHN H. BAILEY: About three months ago I had occasion to observe two patients, a brother and sister, with a typical pseudo-Argyll Robertson pupil, and I was rather intrigued when I looked up the literature on the subject. I do not wish to detract any credit from Adie; but in 1921 Behr elaborately described pupillotonia, and I feel therefore that this condition might be called the Behr-Adie syndrome rather than the Adie syndrome. Adie's paper appeared in 1931, and Behr's very clarifying article appeared in 1921, ten years previously. I think that one often misses this syndrome because one is not sufficiently persistent in making examinations. The pupil will not react to light apparently, but if Behr's technic is carried out and the patient is placed in a dark room for about an hour there will be a slight dilatation of the pupil. However, when the patient is suddenly exposed to bright daylight, there will be a moderate contraction of the pupil; then the pupil will contract a little more and, finally, it will resume its former size, but this reaction is by no means so extensive as the convergence reaction. It is this reaction which gives the syndrome its name—it is a tonic reaction to convergence. At times it will take as much as five minutes before this reaction to convergence will appear. Most examiners do not have sufficient patience to wait that long. If the patient does not show a reaction in a minute or two, the examiner ceases to look for it, but if he would wait five minutes, a typical convergence tonic reaction would be observed. In distinguishing between the Argyll Robertson pupil and the pupillotonic condition, it is necessary to bear in mind that the psychosensory reflex is retained in pupillotonia while in the Argyll Robertson pupil it is absent. Just as there is a spasmodic contraction of the sphincter iridis on convergence, there may be a spasmodic contraction of the ciliary muscle, so that when a patient looks at a distant object everything looks blurred because there is a spasm of accommodation. When the patient squeezes the eyelids or tries to close them against resistance, there will be a contraction of the

pupil, the Westphal-Piltz reflex. In pupillotonia there may be a sustained contraction of the pupil, while in the presence of an Argyll Robertson pupil this reflex offers nothing unusual. .

DR. ERNST WALDSTEIN: I think that in the great majority of cases reported by Adie the characteristic tonic pupil was limited to one side, the other pupil being normal. I noticed also that in most of the cases reported by Dr. Kennedy and his associates there was a unilateral pathologic pupil. This unilaterality, therefore, seems to be a convenient characteristic of Adie's disease, in contradistinction to the classic Argyll Robertson symptom.

DR. HERMAN WORTIS: I think that we can agree with Dr. Dunnington.

Regarding our use of the term "Adie's syndrome," we agree that Behr described this condition before Adie, but, as we have already pointed out, Saenger and Strasburger described typical cases before both of them, and it is not unlikely that some historically minded colleague, on searching the literature, will find that the inevitable Hippocrates antedated them both. We used the term "Adie's syndrome" because it has apparently been accepted in the literature.

The apparent lack of reaction to light in these cases cannot be stressed too much. The pupils apparently do not react to light, but if the patient is placed in a dark room a slight reaction to light is usually obtainable. The fact that the pupils of such persons do react to convergence is probably the result of many factors, not the least of which is that convergence is a much stronger stimulus. As a matter of fact, the entire pathophysiology of pupillary reactions is still a matter of much debate. The peripheral autonomic control of the pupil is too well known to bear repetition here. With regard to the central control of pupillary reactions, little is known. There is, however, much evidence to indicate that there is a reflex arc which, passing through the hypothalamus, controls the sympathetic innervation of the pupil. There is also evidence that the cerebral cortex exerts a control over pupillary reaction, largely through the parasympathetic pathways. These findings, however, are still in the experimental stage, and until more definite knowledge is obtained they are probably best not applied to clinical problems.

Dr. Bailey also mentioned the spasmodic contraction of the sphincter iridis in one of his cases. This was also true in case 1 of our series, in which it took one hundred and twenty seconds for the pupil to reach its peak dilatation after contraction.

The problem of unilaterality is difficult to answer. In the cases reported by R. Foster Moore, the left pupil was usually affected. This brings up the entire problem of cerebral dominance, which Dr. Kennedy has stressed so much in his neurologic teachings. It is known that the left side of the brain is usually dominant in right-handed persons, but to go from there through the hypothalamic nuclei and back to the pupil takes one into the realm of speculative pathology—a realm we are anxious to avoid.

PNEUMOCOCCIC BACTERIOPHAGE

ITS APPLICATION IN THE TREATMENT OF ULCUS CORNEAE SERPENS

A. M. RODIGINA, M.D.

PERM, U. S. S. R.

Bacteriophagy was discovered by the French scientist D'Herelle in 1917.

According to D'Herelle's view of the bacteriophage as a living body, its main features are as follows: (1) It is capable of bringing about profound changes in the microbial cell leading to its entire dissolution; (2) it is capable of propagation while affecting bacteria and (3) it can exert its action in the presence of a living cell.

D'Herelle's phenomenon is detected by microscopic examination of cultures on nutritive mediums.

On fluid mediums bacteriologic cultures become clear in eight hours after inoculation in the presence of a phage.

On solid nutritive mediums the bacteriophage is detected by the formation of so-called sterile spots (*taches vierges*), or "negative" colonies. For this purpose the tested filtrate and the culture are mixed and then inoculated in agar cups at various intervals. In from eighteen to twenty-four hours at 37 C. either incomplete growth results, i. e., free spaces are seen (*taches vierges*) between the colonies in the cups or no growth is obtained.

The microscopic picture shows what profound alterations take place in the bacterial cell previous to its entire dissolution.

The activity of the bacteriophage increases with each succeeding inoculation and can be determined by titration.

Against the pneumococcus, which is of much importance in diseases of the eye, no bacteriophage has been discovered previous to the findings reported here.

The bacteriophage has acquired a double importance in medicine: as a prophylactic and as a remedy.

The experiments with phagoprophylaxis and phagotherapy in typhus (typhoid), dysentery, paratyphus and other gastric infections in man (reported by D'Herelle, Handuroy, Eliava, Melnik, Khastovich,

From the Ophthalmological Clinic of the Perm Medical Institute, Prof. P. I. Chistyakov, Director.

Burstein and others) led to the conclusion that in the future it will be necessary to increase the application of the bacteriophage, especially in bacillary dysentery, since bacteriophagotherapy, provided certain obligatory moments are observed, unquestionably lessens mortality and accelerates recovery.

In ophthalmology the bacteriophage is so far little known. I succeeded in finding in the literature, chiefly the foreign literature, several reports of work along this line, partly experimental and partly clinical. Demme, Giano Piero, Collevati, Max Strumio, Hunter Scarlett, Thibairenq, Town and Frisbee are the few authors who have studied the bacteriophage in relation to ophthalmology.

Prof. P. I. Chistyakov suggested that I devote my studies to isolation of the pneumococcic bacteriophage and, if I succeeded in isolating it, to its application as a remedy for pneumococcic diseases of the eye, chiefly for serpiginous ulcer of the cornea.

In the available literature are hints of several ineffective attempts to obtain the pneumococcic bacteriophage. I refer to the works by Brainard and Noble, Eddy, and Balsamelli.

EXPERIMENTS IN ISOLATION OF THE PNEUMOPHAGE

At the beginning of my work I availed myself only of ophthalmic material. The bacterial flora of material from serpiginous ulcers of the cornea was tested, and the pneumococcus, if present, was isolated from other micro-organisms.

Then the pneumococcic culture, after being verified, was inoculated in serum bouillon and in from eighteen to twenty-four hours was passed through a Berkefeld filter.

The filtrate, after being tested for sterility, was tested for its lytic effect. But I failed in all my attempts to obtain the bacteriophage from pneumococcic cultures. I managed to discover the cause of my failure later when working at the Leningrad Pasteur Institute.

Special methods are required to obtain the bacteriophage phenomenon, since it was established by D'Herelle's observations that the bacteriophage is not always present in material from a diseased organism; it cannot be revealed whenever one chooses to determine its presence, but its appearance coincides with a definite state of the organism, namely, the period of recovery.

Consequently in order to secure the bacteriophage it was necessary to study material systematically, at times perhaps for rather long periods. Regrettably, this principle cannot be applied to the material obtained from the cornea affected with serpiginous ulcer.

It was necessary to obtain initial material from some other source. The vicinity of the therapeutic clinic of the Perm Medical Institute

enabled me to set about systematic daily investigation of the sputum of persons with pneumonia.

The isolation of the pneumococcic bacteriophage was carried on by a common method.

I made mass inoculations of sputum on fluid and solid nutritive mediums, sometimes no less than from ten to twelve sputums being studied daily. In twenty-four hours, bouillon cultures, after being tested bacterioscopically, were filtrated. Filters failing, I made use of hand-made filters of talc, according to a description given by Borisov and Osher in *Laboratory Practice*, 1934. A model of the filter is shown in figure 1.

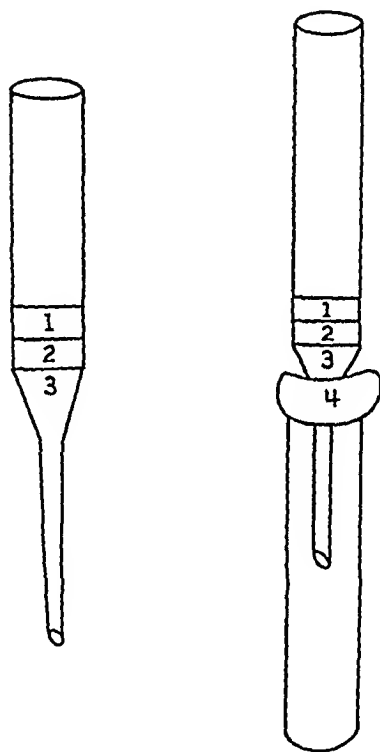


Fig. 1.—Model of hand-made filter used in separating the pneumophage. 1 and 3 are spaces containing cotton; 2 is the space containing talc, and 4 is the cork of cotton.

By means of these methods I succeeded in isolating the first pneumophage in March 1935.

The presence of the bacteriophage was evidenced by complete transparency of the bouillon culture, which set in after from twelve to eighteen hours in a test tube. On solid nutritive mediums the presence of the phage was often revealed in the form of spaces free from cultures (*taches vierges*) and in fanciful forms (fig. 2).

The action of the pneumophage was established by the amount necessary to destroy a definite quantity of bacterial suspension. The bacte-

riophage tested was added in decreasing quantities (1.0, 0.5, 0.3, 0.1, 0.05, 0.03, 0.01, and 0.005 cc.) to the bouillon inoculated with one drop of a bouillon culture 24 hours old. The least quantity of the phage which could produce complete transparency of the culture was indicative of the strength of the bacteriophage.

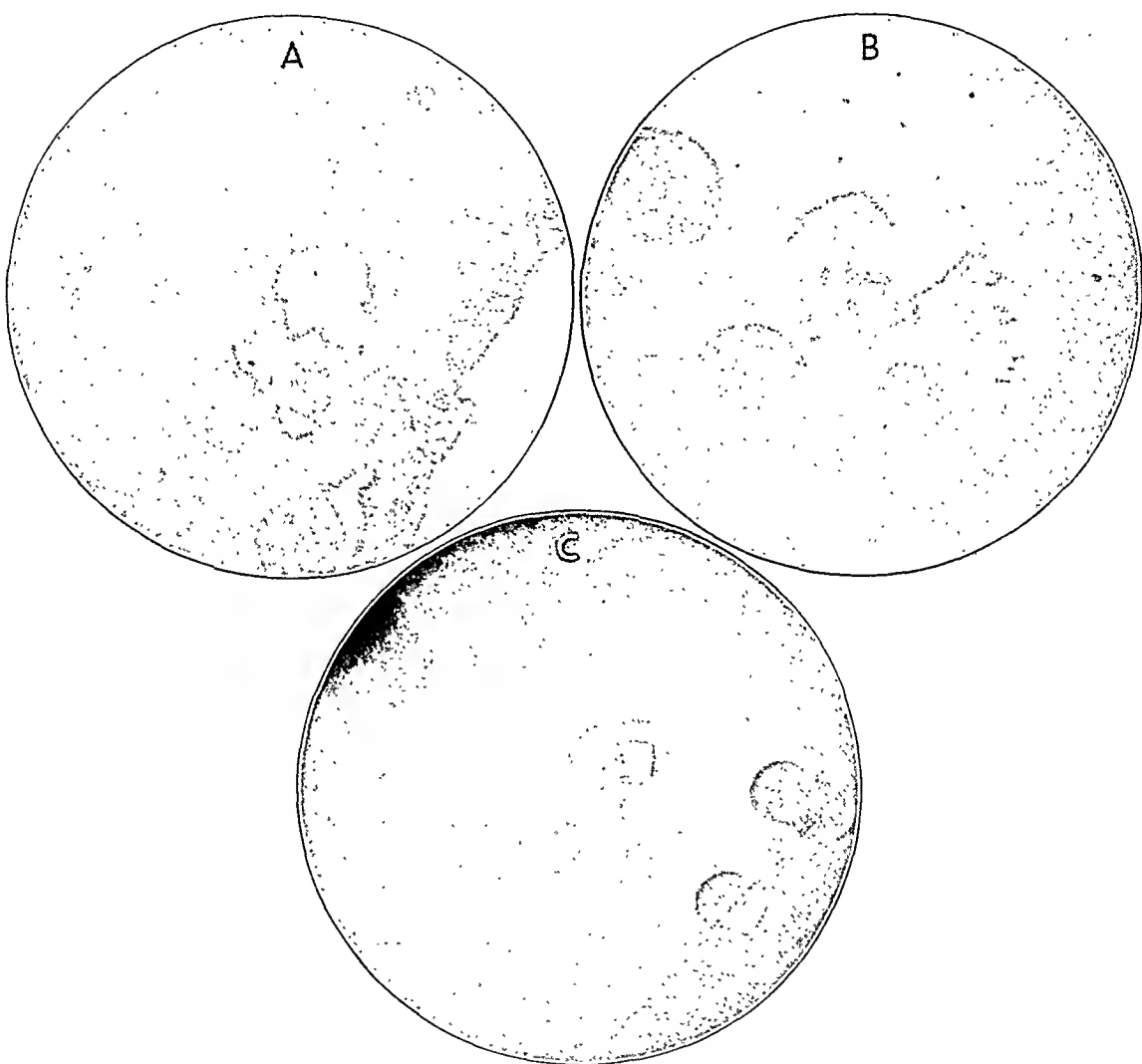


Fig. 2.—A, pneumococcic culture showing *taches vierges*; B and C, pneumococcic culture showing fanciful forms.

Spontaneous lysis, which occurs not infrequently in old museum cultures, took place in these experiments, but this has nothing in common with the lysis caused by the true bacteriophage (Brainard and Noble).

From the table it is clear that the pneumophage obtained from various pneumococcic cultures caused the dissolution of pneumococcic

cultures of any type, but not of all cultures to the last. In these experiments, as in many others, three kinds of pneumococcic cultures were distinguished, differently relating to the pneumophage independently of their type: (1) lysosensitive strains, (2) strains capable of changing from lysoresistant to lysosensitive ones if the phage is in action and (3) lysoresistant strains not in the least affected by the bacteriophage. Each of these groups contains representatives of all types of pneumococci, and consequently there is no basis for speaking of the strict type specificity of the pneumophage. It was found that the pneumophage can be obtained from pneumococcic cultures of every type and that such a pneumophage not only acts inside the initial cultures of its type but spreads its lytic action also outside of the typical realm of the pneumococcus.

The extent of the lytic energy is not closely connected with the type of pneumococcus, as I have obtained a very active pneumophage with a high indicator of action from cultures of pneumococcus type X. This bacteriophage was no less strong than that obtained in the virulent culture of pneumococcus type I, but the available data suggest that the pneumococcic phage obtained from cultures of pneumococcus type III is weaker than those obtained from cultures of other types of pneumococcus.

On the other hand, cultures of pneumococcus type III are known to be more resistant against the bacteriophagic lysis than cultures of any of the other types of pneumococcus. The table also shows the essential property of the pneumophage—its increase in lytic power in a test tube. If at the beginning of the experiment lysis of a pneumococcic culture required 0.3 cc. of the pneumophage, later on this quantity became reduced by degrees and finally amounted to such minimum values as from 0.01 to 0.005 cc.

Summarizing the data in the literature and the results of my own investigations, I am led to the following conclusions:

1. The role of the bacteriophage phenomenon in both therapeutic and prophylactic medicine is now completely proved; in ophthalmology, however, this problem has practically not been broached.

2. Notwithstanding many attempts to isolate the pneumophage, this has not been accomplished heretofore.

3. I was the first to succeed in isolating the pneumococcic phage, which fully meets the requirements for a true bacteriophage in the following respects: (a) it is capable of producing changes in the pneumococcic culture, beginning with the production of fanciful colonies (*Flatterformen*), mucous groups and sterile regions (*taches vierges*) and ending in complete lysis of pneumococcic cultures. (b) It can be gradually intensified by means of a series of procedures. (c) It can

exist only with the pneumococcic culture; if isolated, it quickly renders the pneumococcus inactive.

4. The process of isolating the pneumophage calls for definite methods. It is necessary systematically to study the material in which the pneumococcus is contained.

Ratio of Bacteriophages to Different

Type of Pneumococcus	Pneumococcic Cultures	Amount of Culture	Tested Pneumophages													
			Belyayeva				Orlova				Bogdanova			Godshivalova		
			Dates of Observation													
			3/7	3/11	3/15	3/30	2/21	3/1	3/9	3/12	3/9	3/12	3/20	3/24	3/25	3/28
			Amount of Bacteriophage, Cc.													
			0.5	0.5	0.25	0.1	0.5	0.25	0.1	0.05	0.5	0.5	0.25	0.05	0.01	0.005
IV	Novinskaya.....	In all experiments 1 drop of nondiluted bouillon culture of pneumococcus	—	+	+	+	+	+	+	+	+	+	+	+	+	+
IV	Orlova.....		—	+	+	+	+	+	+	+	—	—	+	+	+	+
III	Khokhlova.....		—	—	—	—	+	+	+	+	—	+	+	—	—	—
III	Fedotova.....		+	+	+	+	+	+	+	+	—	—	—	—	—	—
II	Belyayeva.....		+	+	+	+	+	—	—	+	—	+	+	+	+	+
II	Bogdanova.....		+	+	+	+	+	+	+	—	+	+	—	—	+	+
I	Mingaleyeve.....		—	+	+	+	..	..	..	..	+	+	+	+	+	+
I	Malkova.....		—	—	—	—	+	+	+	+	+	+	+	+	+	+
I	Kafakova.....		—	—	—	—	..	..	..	..	..	..	..	..	..	..
I	Varova.....		—	—	—	+	+	+	+	+	—	—	—	—	—	—
II	Nechayeva.....		—	—	+	+	—	—	—	—	—	—	—	—	—	—
IV	Permyakova.....		—	+	+	+	—	—	—	—	—	—	—	—	—	—
IV	Labdeyeva.....		—	—	—	+	..	..	..	..	—	—	—	—	—	—
I	Lychova.....		—	—	—	+	..	..	..	..	..	..	..	..	..	..
I	Suryanova.....		—	—	—	+	..	..	..	..	..	..	..	..	..	..
IV	Zolotukhina.....		—	+	+	+	+	+	+	+	—	—	+	+	+	+
III	Chazova.....		..	..	..	..	..	..	..	..	..	..	..	..	..	..
I	Rubtsova.....		..	..	..	..	..	..	..	..	..	..	..	..	..	..
II	Lahhvatkina.....		..	..	..	..	..	..	..	..	..	..	..	..	..	..
I	Podshivalova.....		..	..	..	..	..	..	..	..	..	..	..	..	..	..
II	Yermakova.....		..	..	..	..	..	..	..	..	..	..	..	..	..	..
II	Nyetsvetayeva.....		..	..	..	..	..	..	..	..	..	..	..	..	..	..
IV	Chirkova.....		..	..	..	..	..	..	..	..	..	..	..	..	..	..
III	Boney.....		..	..	..	..	..	..	..	..	..	..	..	..	..	..
II	Mezentseva.....		..	..	..	..	..	..	..	..	..	..	..	..	..	..
IV	Karpova.....		..	..	..	..	..	..	..	..	..	..	..	..	..	..
III	Medvedyeva.....		..	..	..	..	..	..	..	..	..	..	..	..	..	..

5. The time of appearance of the pneumophage in a person with pneumonia always coincides with the period of convalescence; namely, it appears in the sputum after the crisis.

6. I also succeeded sporadically in isolating the pneumophage from sputum of persons with ocular disease and pneumonia.

7. No differences in the properties of the pneumophage of pulmonary origin and those of the pneumophage of ocular origin were recorded.

EXPERIMENTS IN TREATMENT OF ULCUS CORNEAE SERPENS
WITH THE PNEUMOPHAGE

When setting about the work of applying the pneumophage as a remedy for serpiginous ulcer of the cornea I wondered whether any new remedies were required for this condition. I discovered an ample

Strains of Pneumococcic Cultures

Tested Pneumophages																			Control Cul- tures
Yermakova				Karpova				Suryanova											
Dates of Observation																			
3/26	3/31	4/20	4/25	9/6	9/8	9/12	9/12	9/9	9/13	9/13	9/18	11/9	11/12	11/12	11/12	11/16	11/16	11/16	
Amount of Bacteriophage, Cc.																			
0.5	0.1	0.1	0.01	0.5	0.5	0.1	0.05	0.5	0.5	0.25	0.25	0.5	0.5	0.25	0.1	0.1	0.05	0.01	
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..	+	+	+	+	+	+	+	+	+	+	+	—
..	—	—	—	—	—	—	—	—	—	—	—	—
..	+	—	+	+	+	+	+	+	+	+	—	—

supply of all kinds of treatment suggested by different writers for this purpose.

After studying the literature I became convinced that, notwithstanding the number and diversity of ways of treating ulcus corneae serpens, the practicing ophthalmologist has no reliable remedy, and that some new method of treatment is needed.

In contradistinction to pharmaceutic, physicochemical and surgical methods of treating ulcus corneae serpens, which produce great destruc-

tion of the sound tissue of the cornea, biologic methods may be tried, which are based on the immunization phenomenon. Beautifully worked out in theory, they have not, however, been borne out in practice.

The structural peculiarities of the cornea—its density and the absence of blood vessels—seem to exclude any hope for success in general immunization. Serotherapy, which was ardently advocated at one time by Römer, has not quite found its application in the treatment of serpiginous ulcer, for which it was chiefly suggested by that author.

It would be more reasonable to make use of local immunization of ocular tissues for treating pneumococcic ulcer of the cornea by the application of the active virus after the method of Bezredka. The main point to be taken into account in effective treatment with this method, viz., the possibility of the closest contact of the morbid region with the immunizing agent, in this case with the active virus, can be secured to the highest degree in cases of *ulcus corneae serpens*. Regrettably, no literature relating to the question exists.

Treatment of corneal diseases by the bacteriophage appears to meet this demand still more successfully. The main property of the bacteriophage—production of lysis of the bacterial culture—may be made use of on the very spot and in the very region affected. The effect of applying the bacteriophage will be still greater than it would be if applied elsewhere, since it will exert a strictly specific influence on the respective culture. The third favorable aspect is the complete innocuousness of the bacteriophage to the tissue of the cornea.

At first I tried to verify and study the effect of the pneumophage on the eyes of animals. For this purpose I carried out experiments on sixteen rabbits, inoculating the pneumococcus into the cornea and inducing *ulcus corneae serpens*. With a view to infecting the cornea, I utilized virulent strains of different types of the pneumococcus, having isolated them mostly from the sputum of persons with pneumonia. I applied as treatment either the monophage, which produced lysis of a given pneumococcic culture in a test tube, or the polyphage, composed of several strains of the pneumococcic bacteriophage.

A description of the methods and results in these experiments follows. In the series of experiments the methods applied were the same as were the time of beginning the treatment with the bacteriophage, the duration of observation, the time of enucleation of the eye and other factors.

On the fourth or fifth day after the inoculation all the rabbits showed *ulcus corneae*. Growing superficially and in depth from day to day, the process acquired an appearance typical of *ulcus corneae serpens*. Apart from infiltration and extension of the ulcer at its margin, pus appeared in the anterior chamber of the eyes of many of the rabbits. The culmination of the ulcerous process was reached on the seventh day.

From this day on I began treating some of the rabbits, i. e., eleven, with the pneumophage; the rest (the control animals) were not treated.

From the results of the experiments on the rabbits' eyes with induced *ulcus corneae serpens* the following conclusions may be drawn:

1. The results obtained by me with the pneumophage in eyes with *ulcus corneae serpens* open broad views in ophthalmology and permit me to call ophthalmologists' attention to this new remedy.

2. The pneumophage exerts an obvious curative action, quickly stopping the ulcerous process and preventing the destruction of corneal tissue. Eventually the ulcer in the eyes of the animals that were treated by the pneumophage was represented by a small, limited dim area of the cornea.

3. In the eyes of the control animals the ulcerous process of the cornea took a painful course and ended in atrophy of the eyeball in one case and in the development of a large coalescent wall eye in another.

My clinical observations on the results of application of the pneumophage for the treatment of *ulcus corneae serpens* are so far scanty, and the study has not advanced beyond the stage of collection of clinical material.

No final conclusions are offered at this stage of the work, but the first impressions obtained are rather encouraging. Every ophthalmologist knows that it is hard to treat *ulcus corneae serpens*, and that all the present remedies, even the most heroic ones, remain ineffective. That is why I call the attention of scientists to this new way of treating *ulcus serpens*.

ABNORMAL ARTERIOVENOUS COMMUNICATION IN THE ORBIT INVOLVING THE ANGULAR VEIN

REPORT OF A CASE

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AND

GUSTAVE B. FRED, M.D.

BOSTON

An abnormal arteriovenous communication involving the angular vein is apparently an extremely rare occurrence, since, so far as we have been able to ascertain, no such involvement has hitherto been reported. The rarity of the condition, as well as the unusual features of postoperative convalescence, justifies this report.

REPORT OF CASE

History.—An Italian woman 23 years of age in the eighth month of pregnancy noticed exophthalmos of the left eye. Within three days the swelling reached its maximum. The patient noticed no pain or alteration of vision. She did, however, hear a peculiar sound in her head and felt a pulsation in the region of the left eye at night after she retired, but she was unable to describe the character and quality of the sound. She accepted this condition as a part of the discomfort incident to the late stages of pregnancy, although she had not experienced this with her four previous pregnancies, one of which terminated in miscarriage. Although the patient was vague about all the details of the history, she was sure that she had never sustained any direct or indirect trauma to the region of the left eye or to the head in general.

Nine weeks after the onset of the exophthalmos (two weeks after parturition) the patient came to the Massachusetts Eye and Ear Infirmary for diagnosis and treatment of the exophthalmos.

Examination.—The left eye was 7 mm. farther forward than the right eye, as determined by the Hertel exophthalmometer. It appeared to be pushed straight forward. Some limitation of motion was present in looking up and to the left. There was no pulsation of the eye. The exophthalmos could be reduced considerably by pressure on the lids.

The presence of considerable edema of the nasal bulbar conjunctiva and swelling of the tissues of the nasal third of the lids accentuated the appearance of exophthalmos. The upper lid showed more swelling than the lower. There was also considerable swelling over the tear sac. The skin over the swelling and the chemotic conjunctiva was only moderately hyperemic. The tumor also could be partially reduced by pressure. An intermittent thrill was easily felt, the inter-

From the Massachusetts Eye and Ear Infirmary.

missions being synchronous with the pulse in the temporal artery. The rate of the intermissions of the thrill seemed synchronous with the arterial pulse. On auscultation a loud, blowing, continuous murmur was heard. It was loudest over the angular vein, just above the inner canthus. It could not be heard over the temporal region or in the neck. Although the murmur was continuous, its volume and character changed in synchronism with the arterial pulsation. Firm compression of the left internal carotid artery reduced the volume and character of the murmur and caused the palpable thrill to cease. Pressure on the angular vein well below the tumor produced similar results, although the change in the murmur was less striking.

Vision was 20/40 in each eye. The retinal veins of the left eye were engorged.

The left preauricular lymph node was somewhat enlarged and easily palpable.

The Hinton test of the blood was negative.

An x-ray film of the skull showed a shadow in the left antrum. On the basis of this a cyst of the left antrum was found and drained. Clear serous fluid was obtained from the cyst.

A diagnosis of an abnormal arteriovenous communication was made. Because the murmur was limited definitely to the region of the left orbit, it was thought that the aneurysm was neither in contact with the eye nor behind the equator of the globe.

On the basis of these opinions an exploratory operation was decided on.

Operation.—With the patient under ether anesthesia, exploration was made for an aneurysm at the inner angle of the left orbit.

The incision, similar to that commonly used in external ethmoidectomy, was made on the nose. Immediately under the subcutaneous tissue a large, tortuous angular vein was found. It was some 10 mm. in diameter. Further dissection revealed that it rapidly became narrow, approximating the normal size at about the lower end of the nasal bones. Its tributaries became normal in size at the supra-orbital ridge. Branches from the nose dilated just before they entered the vein. At the level of the inner canthus, whirls and eddies of arterial blood could be seen entering the vein. Each tributary of the enlarged vein was tied near the point of entrance. The angular vein was tied where it became more nearly normal in size. The dilated vein was then cut away from its attachments. At the level of the inner canthus, where the whirls and eddies were seen, a small artery was found to be entering on the deep surface of the vein. The artery was thought to be the infratrochlear branch of the ophthalmic artery. It was tied and cut. The enlarged vein was removed. A sterilized stethoscope was then applied, and the murmur was found to have ceased. The thrill could not be felt. The orbital tissues were dissected from the medial wall and the anterior ethmoidal vessels and nerves located. The vein seemed to be dilated. These vessels were tied off but not cut. At the end of the operation the swelling of the lid and the exophthalmos increased. The incision was closed tightly with sutures. To keep the lids closed it was necessary to suture them together. A mattress stitch was taken with no. 6 black silk. A pressure bandage was applied, and the patient was returned to the ward in good condition.

Postoperative Course.—Some eight hours later the exophthalmos had increased materially. Edema of the conjunctiva had increased to such an extent that the conjunctiva partially protruded between the lids in spite of the suture in the lid.

Three days after the operation the proptosis and edema were so great that the sutures in the lid broke down. The cornea would have been exposed had the edematous bulbar conjunctiva not protected it. The congestion of the retinal

veins had increased considerably, and papilledema of 2 D. was present. The portion of the retina temporal to the disk in the region of the macula was edematous.

The temperature of the lids of each eye was taken by inserting a clinical thermometer into the conjunctival sac. The temperature on the left was 1 degree higher than that on the right.

The increase in the exophthalmos and in the edematous swelling of the lids and conjunctiva was so marked that necrosis of the lids and conjunctiva seemed imminent. The eye was immobile. Sutures were run through the edematous conjunctiva in the hope that some of the fluid would run out along them. There was some drainage, but not sufficient to reduce the edema appreciably. Neither compresses soaked in hypertonic solution of magnesium sulfate nor the application of a pressure bandage had any apparent effect in reducing the edema. After temporizing some eight days with these measures there was a slight but definite reduction in the edema of the lids, accompanied by a slight return of motility to the eye.

After the use of the pressure bandage some wrinkles of the cornea or corneal infiltrates were observed. The intra-ocular pressure was elevated to 35 mm. (Schiötz). As the condition was unrelieved by a miotic, paracentesis was done. Increase in tension did not recur. It is interesting to note that glaucoma and papilledema were simultaneously present. After the use of the miotic, progress of the papilledema could not be observed.

Twenty-four days after the original operation the reduction in the edema and in the exophthalmos was sufficient to permit resuturing of the lids after external canthotomy. A sufficient gap was left between the sutures to permit observation of the cornea, measurement of the ocular tension by means of the Souter tonometer and the administration of miotics. After operation the edema of the conjunctiva abated more rapidly. When the sutures were removed five days after their introduction, only a small amount of edematous conjunctiva projected through the lids in the region of the caruncle.

Reduction of the exophthalmos gradually continued, as did the papilledema and the edema of the conjunctiva and lids. The motility of the left eye gradually returned to normal. Some seven months after operation the only apparent deformity was the operative scar and a white scar in the macula. The left visual field was concentrically contracted some 30 degrees, and the left blindspot was twice the normal size. Visual acuity was 20/50.

COMMENT

The spontaneous appearance of an abnormal arteriovenous communication in the latter part of pregnancy in a multipara must have been due to some congenital defect in the vascular bed. The fact that the communication was directly from the artery to the vein indicates that its origin was probably not through the medium of an angioma. A lack of sufficient musculature in the arterial wall may have produced a simple aneurysm,¹ which may have ruptured into the vein later. Vestigial remains of prenatal communications between vessels destined

1. Forbus, W. D.: On the Origin of Miliary Aneurysms of the Superficial Cerebral Arteries, *Bull. Johns Hopkins Hosp.* 47:239 (Nov.) 1930.

to become an artery and a vein² can reopen. The changes in the circulation incident to the pregnancy may have had a definite contributory effect, but why this should not have occurred in a pregnancy earlier than the fourth is not obvious. Other than the one miscarriage and the aneurysm, there was no evidence suggestive of syphilis.

The increase in the exophthalmos and in the edema of the lids immediately after the removal of the vein and the abnormal arteriovenous communication, as well as the increase in the temperature of the left lid, is consistent with changes in other parts of the body after removal of an abnormal arteriovenous communication. Reed³ has shown that there is an increase in the caliber and tortuosity of vessels, as well as an actual increase in the number of capillaries, in the region of arteriovenous aneurysms. These vessels have been accustomed to a very sluggish circulation, due to the marked elevation in the venous pressure and some reduction in the arterial pressure. Sudden restoration of more or less normal arterial and venous pressures to the area improved the circulation through the dilated, tortuous vessel and the increased capillary bed sufficiently to increase the edema and elevate the temperature. The orbit seems more prone to edema than most other tissues of the body, owing to a possible difference in the lymphatic drainage.

If a period of time had been allowed to elapse before the aneurysm was removed, possibly a better collateral circulation would have been provided, due to the arteriovenous communication itself.⁴

One of us (G. B. F.) felt that had only the arterial communication to the vein been tied at the original operation and the venous return not been severed, the resultant proptosis and edema might not have occurred. Obliteration of the communication between an artery and a vein is not conducive to permanent relief, the communication usually reestablishing itself, according to many observers. On a somewhat different basis, tying of the left carotid artery was considered during convalescence (G. B. F.).

2. Smith, Ferris: Congenital Arteriovenous Fistula in Tympanum, *Arch. Otolaryng.* **10**:32 (July) 1929.

3. Reed, M. R.: Studies on Abnormal Arteriovenous Communications, Acquired and Congenital: Report of Series of Cases, *Arch. Surg.* **10**:601 (March) 1925; Abnormal Arteriovenous Communications, Acquired and Congenital: Origin and Nature of Arteriovenous Aneurysms, *ibid.* **10**:996 (May) 1925; Abnormal Arteriovenous Communications, Acquired and Congenital: Effects of Abnormal Arteriovenous Communications, *ibid.* **11**:25 (July) 1925; Abnormal Arteriovenous Communications, Acquired and Congenital: Treatment of Abnormal Arteriovenous Communications, *ibid.* **11**:237 (Aug.) 1925; *Am. J. Surg.* **14**:17 (Oct.) 1931.

4. Koster, W.: Beiträge zur Lehre von Glaukom, *Arch. f. Ophth.* **41**:30, 1895.

The glaucoma was probably due to back pressure in the vortex veins, due to the marked increase in the orbital pressure. Temporary glaucoma has been produced in laboratory animals by blockage of vortex veins.⁴

Papilledema occurs with increased orbital pressure and in itself is not surprising.

The reduction of the visual field can be explained better on the basis of prolonged papilledema than as due to the glaucoma, since the defect in the field was not typical of glaucoma, and the glaucoma was of short duration. Loss of macular vision was due to injury of the macula, resulting in the scar already mentioned.

SUMMARY AND CONCLUSIONS

A spontaneous arteriovenous aneurysm between the angular vein and the infratrochlear branch of the ophthalmic artery was cured by removal.

The resultant exophthalmos, increased temperature and papilledema were probably due to sudden restoration of a relatively normal circulation to a vascular bed accustomed to abnormal, sluggish circulation.

The glaucoma was probably due to closure of vortex veins by passive congestion or by increased orbital pressure.

DIPLOCOCCUS PNEUMONIAE AND STREPTOCOCCUS VIRIDANS IN OCULAR DISEASES

REPORT OF ONE HUNDRED CASES

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Diplococcus pneumoniae was classified as types I, II and III and group IV prior to 1929, when Cooper¹ and her co-workers separated group IV into twenty-nine additional types. At the present time the recognized types are designated by the Roman numerals I to XXXII, inclusive. A number of important studies of the pneumococcus in ocular diseases have appeared in the literature, but a study of the types included in group IV has not been reported. Römer² unsuccessfully attempted to treat *ulcus serpens corneae* with antiserums, but, since approximately 75 per cent of the pneumococci which cause ophthalmic disease are group IV organisms, specific serum reactions were not to be expected. Consequently, it appeared practical to undertake an investigation of the organisms in this heterogenous group.

In 1917 Avery and his co-workers³ studied the relative incidence and mortality for the four original types of pneumococci in pneumonia (table 1). They established types I, II and III as the etiologic agents in 76 per cent of the cases of pneumonia, while group IV, although most commonly found in the oral secretions of normal persons, was responsible for the condition in only 24 per cent. Since that time many investigations concerning the pneumococcus, including group IV, have

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1. Cooper, G.; Edwards, M., and Rosenstein, C.: The Separation of Types Among the Pneumococci Hitherto Called Group IV and the Development of Therapeutic Antiserums for These Types, *J. Exper. Med.* **49**:461-474 (March) 1929. Cooper, G.; Rosenstein, C.; Walter, A., and Peizer, L.: The Further Separation of Types Among the Pneumococci Hitherto Included in Group IV and the Development of Therapeutic Antisera for These Types, *ibid.* **55**:531-554 (April) 1932.

2. Römer, P.: Experimentelle Grundlagen für klinische Versuche einer Serumtherapie des *Ulcus corneae serpens* nach Untersuchungen über Pneumokokkenimmunität, *Arch. f. Ophth.* **54**:99-200 (April) 1902.

3. Avery, O. T.; Chickering, H. T.; Cole, R., and Dochez, A. R.: Acute Lobar Pneumonia: Prevention and Serum Treatment, Monograph 7, Rockefeller Institute for Medical Research, 1917.

been made; these studies have shown that the incidence of the types and their virulence, complications and other aspects vary with the season, year, locality and age group affected. In general, the more acute pneumococcic infections are due to type I, II or III, while the less acute or atypical conditions are caused by some organism of group IV.

Gundel,⁴ in a study of 3,000 normal persons, found that of the pneumococci in the upper respiratory tract, from 1 to 4 per cent were types I and II, that approximately 10 per cent were type III and that at least from 50 to 60 per cent were of group IV. He noted that in at least from 65 to 70 per cent of the cases of lobar pneumonia the condition was due to type I or II. He believed also that group IV was more common in cases of conjunctivitis and ulcus serpens corneae than the more virulent types I, II and III. In a study of 3,682 cases of pneumonia caused by the pneumococcus at the Boston City Hospital, Finland⁵ noted that in approximately 49 per cent the condition was due to type I, II or III but that other frequently occurring types were

TABLE 1.—*Relative Incidence and Mortality for the Four Original Types of Pneumococcus in Pneumonia*

Type of Pneumococcus	Incidence, Percentage	Mortality, Percentage
I.....	33	25
II.....	31	32
III.....	12	45
Group IV.....	24	16

V, VII, VIII, X and XIV. It is of some interest to note that he found the following types, in the order named, caused acute lobar pneumonia in 79 per cent of the cases: I, III, II, V, VIII and VII; in 50 per cent of cases of atypical pneumonia the condition was due to type III, VIII, X, XX, XVIII or VIII. In a study of 4,048 cases of endemic pneumonia at the Harlem Hospital, Bullova and Wilcox⁶ attempted to show the great variation of types as regards mortality, seasonal incidence, age groups, bacteremia and other aspects. Types II, III, XV and XXIII were found to be the most fatal for adults, while types XIII, XXVIII, XXIII and XV most often caused death in children.

4. Gundel, M. I.: Mikrobiologie, Immunbiologie, Epidemiologie der Pneumokokkenkrankungen, Klin. Wchnschr. **12**:89-92 (Jan. 21) 1933.

5. Finland, M.: The Significance of Specific Pneumococcus Types of Disease, Including Types IV to XXXII (Cooper), Ann. Int. Med. **10**:1531-1543 (April) 1937.

6. Bullova, J. G. M., and Wilcox, C.: Endemic Pneumonia: Pneumococcic Types and Their Variations in Incidence and Mortality for Adults and Children, Arch. Int. Med. **59**:394-407 (March) 1937.

Although studies concerning the types of pneumococcus in ocular diseases have been fragmentary, it is of interest to compare them with studies of the types found in the flora of the upper respiratory passages and in pneumonia. Table 2 is a compilation showing the types of pneumococcus demonstrated in ocular diseases by Lobeck,⁷ Schmelzer and Eckstein,⁸ Schmelzer,⁹ Lundsgaard,¹⁰ Bracci-Torsi,¹¹ Mikaëljan,¹² Cheney,¹³ Vita,¹⁴ McKee,¹⁵ Jahnke and Wämoscher,¹⁶ Marginesu and Corda,¹⁷ Wright¹⁸ and Lundsgaard.¹⁹ A brief study of this table reveals the fact that only 25 per cent of the pneumococci occurring in ocular diseases belong to types I, II and III, and that 75 per cent are of group IV. The last group includes virulent organisms that are of great importance in pneumonia, but, because of increased frequency, their significance in ophthalmic practice is perhaps even greater.

7. Lobeck, E.: Zur Frage der Pneumokokkeninfektionen am Auge, *Arch. f. Ophth.* **127**:395-400 (Oct.) 1931.

8. Schmelzer, H., and Eckstein, E.: Die augenpathogene Bedeutung der Streptokokken und Pneumokokken (547 Untersuchungen), *Arch. f. Ophth.* **132**: 24-33 (March) 1934.

9. It appears that the work of H. Schmelzer (Zur Aetiologie und Therapie des eitrigen Hornhautgeschwüres, *München. med. Wchnschr.* **82**:1906-1907 [Nov. 29] 1935) includes cases of sulcus serpens corneae listed by Schmelzer and Eckstein⁸ and that the latter work includes all the cases listed by Schmelzer (Pneumokokken und Streptokokken am Auge [Nach gemeinsamen Untersuchungen mit Eckstein]), *Zentralbl. f. d. ges. Augenh.* **27**:229, 1932).

10. Lundsgaard, K. K. K.: Pneumokokkeninfektionen des Auges: Prophylaxe und spezifische Therapie, *Hospitaltid.* **68**:505-518, 529, 545 and 553-564, 1925; abstr., *Zentralbl. f. d. ges. Ophth.* **15**:700-701, 1926.

11. Bracci-Torsi, H.: Dacriocistite e pneumococchi, *Ann. di ottal. e clin. ocul.* **61**:29-42 (Jan.) 1933; abstr., *Zentralbl. f. d. ges. Ophth.* **30**:113-114, 1933.

12. Mikaëljan, R. C.: Studien über den Pneumokokkus des Auges: I. Ueber Pneumokokkentypen bei einigen Augenerkrankungen, *Klin. Monatsbl. f. Augenh.* **87**:778-784 (Dec.) 1931.

13. Cheney, R. C.: Types of Pneumococcus Found in Corneal Ulcers, *Internat. Cong. Ophth.* **1**:378-382 (April) 1922.

14. Vita, A.: La classificazione immunologica moderna dei pneumococchi nella patologia oculare, *Zentralbl. f. d. ges. Ophth.* **19**:712-713, 1928.

15. McKee, S. H.: A Study of the Pneumococcus Group from the Inflamed Conjunctiva and Lacrimal Sac, *Am. J. Ophth.* **18**:1021-1029 (Nov.) 1935.

16. Jahnke, W., and Wämoscher, L.: Zur Frage der Serumtherapie bei Pneumokokkenerkrankungen des Auges, *Ztschr. f. Augenh.* **74**:215-222 (June) 1931.

17. Marginesu, P., and Corda: Studi sui pneumococchi, *Atti d. r. Accad. d. fisiocrit. in Siena* **15**:1-3, 1923-1924.

18. Wright, R. E.: Statistics and Professional Report of Government Ophthalmic Hospital, Madras, for the year 1924, Madras, India, Government Press, 1925; cited by Lundsgaard.¹⁹

19. Lundsgaard, K. K. K.: *Acta ophth.* **1**:73, 1923; *Communicat. de l'Inst. sérothérap. de l'État Danois*, 1924, p. 15.

Because of the apparent importance of pneumococci of group IV, a detailed study was made of 100 consecutive cases in which methemoglobin-producing organisms, i. e., *Diplococcus pneumoniae* and *Streptococcus viridans*, were recovered. The organisms were obtained in 14 cases from cultures of material from the conjunctival sac made as a routine preoperatively and in all the other cases in inflammatory diseases such as conjunctivitis, dacryocystitis, corneal ulcers, panophthalmitis and endophthalmitis. Blood agar plates streaked with a platinum loop were incubated forty-eight hours at 37 C. Subcultures were made, after twenty-four hours, in 1 per cent dextrose meat infusion broth and 1 per cent inulin. It was not possible to differentiate *D. pneumoniae* and *Str. viridans* from a study of the cultural characteristics alone. On blood agar the pneumococci usually grew as small, moist, translucent colonies with well defined edges; frequently a definite central depres-

TABLE 2.—*Types of Pneumococcus Demonstrated in Ocular Diseases by Various Investigators*

Condition	No. of Cases	Types I and II	Type I	Type II	Type III	Group IV
Panophthalmitis.....	2	..	1	..	..	1
Ulcus serpens corneae.....	131	..	5	9	20	97
Dacryocystitis.....	99	..	4	11	14	70
Acute conjunctivitis.....	59	..	..	2	8	49
Normal conjunctiva.....	59	..	1	2	8	48
Acute conjunctivitis and dacryocystitis.....	70	..	5	1	3	61
Ulcus serpens corneae and/or dacryocystitis.....	76	4	20	7	..	45
Total.....	496	4	36	32	53	371

sion appeared in the colony after twenty-four hours. The colonies of *Str. viridans* were drier, smaller, more opaque and more coarsely granular than those of pneumococci, although in some instances one would have been in error to use these criteria as a means of differentiation. A halo of green hemolysis was present around the colonies of each type. In dextrose meat infusion broth the pneumococci produced a diffuse growth, while the streptococci usually settled to the bottom of the tubes. It is interesting to note that in this medium streptococci frequently grew in extremely long chains, whereas pneumococci grew in pairs or short chains of not more than ten organisms.

Both streptococci and pneumococci, when grown in meat infusion broth, often appeared elongated when stained with Gram's stain. When applied to secretions taken directly from the eye, the Gram stain often showed typical diplococci; this suggested the presence of pneumococcus, but further investigation often revealed a streptococcus. However, in a number of stains of ocular secretions, streptococci in long chains

were noted. The stain for capsules of Bailey²⁰ was applied to a small number of smears of secretion taken directly from the eye, and in 5 cases of dacryocystitis capsules were present; the organisms were subsequently identified as pneumococci. It is altogether probable that if a more thorough search were made for capsules they would be found more frequently in pneumococcic infections.

When sufficient growth had occurred in the dextrose meat infusion broth (after from ten to twelve hours) the bile solubility was determined by means of a 10 per cent solution of sodium taurocholate, and the type of pneumococcus was ascertained by macroscopic agglutination.²¹ In this series all the organisms agglutinated by antipneumococcic serum, i. e., pneumococci, were bile soluble and fermented inulin, the latter often being coagulated, but those organisms which were not agglutinated, i. e., streptococci, neither were bile soluble nor fermented inulin.

In table 3 the incidence of *D. pneumoniae* and *Str. viridans* in various ocular conditions is tabulated. Among the 100 cases, in 56 per cent the condition was due to *D. pneumoniae*, while in 44 per cent it was due to *Str. viridans*. In only 12 per cent of the former were the organisms types I, II or III, while in 88 per cent they were of group IV; this proportion is similar to the tabulation (table 2) based on a review of the literature. It demonstrates the importance of group IV, and the value of more specific knowledge concerning it, if specific anti-serums are to be of therapeutic value in ophthalmic practice. In general, from table 3 one concludes that the more acute diseases are due to pneumococci and the less acute ones are due to streptococci. The incidence of pneumococci and streptococci appearing on fourteen normal conjunctivae was the same. *Str. viridans* was the cause of chronic conjunctivitis in twice as many cases as pneumococcus, but in sub-acute conjunctivitis the ratio of the incidence of streptococci to pneumococci was 4:3. Pneumococci, occurring in 18 of the 22 cases of acute conjunctivitis, were the most important and most frequent etiologic agents in this condition. Of 3 cases of panophthalmitis, pneumococci were the infecting organisms in 2. In the only case of endophthalmitis the condition was due to *Str. viridans*. Pneumococcus was observed in only 1 case of *ulcus serpens corneae*, while in 3 *Str. viridans* was identified; in 2 cases of *ulcus serpens corneae* associated with chronic

20. Bailey, H. D.: A Flagella and Capsule Stain for Bacteria, *Proc. Soc. Exper. Biol. & Med.* **27**:111-112 (Nov.) 1929.

21. The antipneumococcic serums in this work were obtained through the late Miss Georgia Cooper, of the Bureau of Laboratories of the New York City Department of Health. Serums XXVI and XXX have been omitted, as the former is probably identical with serum VI and the latter is closely related to, or identical with, serum XV.

purulent dacryocystitis, pneumococci were demonstrated in the ocular secretions. Thirteen cases of chronic purulent dacryocystitis are included in this series; in 10 cases pneumococci were observed, while in 3 *Str. viridans* was the causal agent.

Table 3 shows the incidence of the various types of pneumococci and of streptococci in ocular diseases from which organisms were

TABLE 3.—*Incidence of Diplococcus Pneumoniae and Streptococcus Viridans in One Hundred Cases of Ocular Conditions*

Condition	No. of Cases	Streptococcus	Pneumococcus
Normal conjunctiva (preoperative cultures).....	14		
<i>D. pneumoniae</i> , types V, IX, X, XIII, XVII (2), XXXI.....			7
<i>Str. viridans</i>		7	
Chronic conjunctivitis	13		
<i>D. pneumoniae</i> , types IX, XIII, XIV, XXXII.....			4
<i>Str. viridans</i>		9	
Subacute conjunctivitis	28		
<i>D. pneumoniae</i> , types I, VII (2), X (2), XII, XIII, XIV (2), XVII, XXIII (2).....			12
<i>Str. viridans</i>		16	
Acute conjunctivitis	22		
<i>D. pneumoniae</i> , types I (2), II, V, VII (3), VIII, X (2), XII, XIII, XVI, XX (2), XXIII, XXVIII (3), (in one case both VII and XX).....			19
<i>Str. viridans</i>		4	
Panophthalmitis	3		
<i>D. pneumoniae</i> , types III, X.....			2
<i>Str. viridans</i>		1	
Endophthalmitis	1		
<i>D. pneumoniae</i>			
<i>Str. viridans</i>		1	
Corneal ulcer	4		
<i>D. pneumoniae</i> , type VIII.....			1
<i>Str. viridans</i>		3	
Chronic purulent dacryocystitis.....	13		
<i>D. pneumoniae</i> , types I (2), XI A and B, VII, XII, XIV (2), XIX, XXIII (2).....			10
<i>Str. viridans</i>		3	
Corneal ulcer and chronic purulent dacryocystitis.....	2		
<i>D. pneumoniae</i> , types VI A and B, XXIII.....			2
<i>Str. viridans</i>			
Total.....	100	44	57

obtained for this study. Table 4 presents the incidence of the various types of pneumococci; types VII, X, XXIII, I, XIV and XIII, in the order named, were obtained most frequently. In only 1 instance were two types present; this was a case of acute conjunctivitis, in which types VII and XX were demonstrated. Only ten types were not represented in this series.

In several cases the clinical observations associated with this study were of interest. A 60 year old man was admitted to the hospital

because of a conjunctival cyst at the nasal limbus of the right eye. There was a history of injury to this eye forty years previously; the cyst had enlarged recently, but otherwise the eye had given him no discomfort. A culture on blood agar was made from material taken from the conjunctival sac. It was believed that the growth was a simple inclusion cyst, and it was punctured and some fluid removed. The following morning pneumococci were noted on the blood agar plate. Panophthalmitis developed, and on the third day the eye was enucleated. The next morning rigidity of the neck appeared, and a blood culture and a culture made from the spinal fluid grew pneumococci. Organisms from all three sources were agglutinated by the type X antipneumococcus serum. In another patient endophthalmitis followed by septicemia and meningitis developed after a foreign body had entered the eye. The organisms from the vitreous, blood stream and spinal fluid appeared to be similar,

TABLE 4.—Incidence of Various Types of *Diplococcus Pneumoniae* in One Hundred Cases of Ocular Conditions

Type	No. of Cases	Type	No. of Cases	Type	No. of Cases
I.....	5	IX.....	2	XIX.....	1
II.....	1	X.....	6	XX.....	2
III.....	1	XII.....	3	XXIII.....	6
V.....	2	XIII.....	4	XXVIII.....	3
VI A and B....	2	XIV.....	5	XXXI.....	1
VII.....	6	XVI.....	1	XXXII.....	1
VIII.....	2	XVII.....	3		
Total.....					57

but none reacted with any of the antipneumococcic serums, and it was concluded that in all probability *Str. viridans* was the etiologic agent. In both these cases the condition was fatal. In a third case, one of dacryocystitis in a young child, the condition was found to be due to a type I pneumococcus. After a period of conservative treatment the child was discharged from the hospital apparently cured, since all cultures were negative and the lacrimal apparatus was patent, but she returned three months later with purulent dacryocystitis, and a type I pneumococcus was again recovered. The infection had apparently remained latent, as the same type of organism was recovered each time a bacteriologic study was made.

SUMMARY

Studies were made of *D. pneumoniae* and *Str. viridans* in 100 consecutive cases in which these organisms were isolated. In 86 instances the organisms were recovered in cases of ocular inflammation, i. e., conjunctivitis, dacryocystitis, corneal ulcer, panophthalmitis or endoph-

thalmitis, and in 14 instances they were isolated from cultures made as a routine before operation for cataract.

D. pneumoniae occurred in 56 per cent of the cases; in 88 per cent of these the organism was of group IV and in 12 per cent of type I, II or III. In order of frequency, the most common types were VII, X, XXIII, I, XIV and XIII. Only ten of the thirty-two known types were not represented. *Str. viridans* occurred in 44 per cent of the cases.

All the organisms which were agglutinated by the antipneumococcic serums were bile soluble and fermented inulin, while those that were not agglutinated neither were bile soluble nor fermented inulin.

A SPECIAL FORM OF KERATITIS CAUSED BY FRIEDLÄNDER'S PNEUMOBACILLUS

REPORT OF A CASE, WITH REVIEW OF THE LITERATURE

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The pneumobacillus was discovered by C. Friedländer¹ in the fibrinous bronchial exudate and in the pulmonary alveolar tissue of patients with pneumonia. This organism is a short, plump bacillus, subject to great variation in size. It measures, on the average, from 0.5 to 1.5 microns in width and from 0.6 to 5 microns in length. It is gram-negative and immotile. It has no flagella or spores but possesses a capsule and grows luxuriantly on blood agar. It belongs to the general group of *Bacillus mucosus-capsulatus*. Strong² and Perkins³ made important contributions toward its isolation and differentiation from other species of the same group by means of formation of gas and fermentation of sugar. Fricke⁴ and Clairmont⁵ studied thoroughly the distribution of the organism and found that it exists in the nose, mouth, saliva and gastro-intestinal tract of healthy persons, as well as in the various inflammatory lesions of various internal organs. Talamon,⁶ who first experimented on animals with this organism, stated that rabbits are less sensitive to this organism than to the lancet form of diplococci obtained from the sputum and blood of patients with pneumonia. Foà and Rattone⁷ proved that guinea-pigs are extremely sensitive to this organism. These animals usually died of peritonitis two or three days after an abdominal inoculation. In his investigations on this organism, which included its differentiation from the Fränkel diplococci, Fränkel⁸ showed that there are cultural as well as pathogenic differences between the two organisms, the pneumobacillus being able to kill mice while the Fränkel diplococcus cannot do so.

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1. Friedländer, C.: *Virchows Arch. f. path. Anat.* **87**:319, 1882.
2. Strong, L. W.: *Zentralbl. f. Bakt.* **25**:49, 1899.
3. Perkins, Roger G.: *J. Infect. Dis.* **1**:241, 1904.
4. Fricke, C.: *Ztschr. f. Hyg.* **23**:380, 1896.
5. Clairmont, C.: *Ztschr. f. Hyg.* **39**:1, 1902.
6. Talamon, C.: *Progrès méd.* **11**:1030, 1883.
7. Foà, P., and Rattone, G.: *Arch. ital. de biol.* **6**:366, 1884-1885.
8. Fränkel, A.: *Ztschr. f. klin. Med.* **10**:402, 1886.

The importance of this organism in ophthalmology was first emphasized by Perles,⁹ who made experiments on different animals. His technic of inoculation was, briefly, as follows: Three parts of the eye of the animal were chosen for the experiment, namely, the cornea, the anterior chamber and the vitreous cavity. For inoculation of the cornea, a pocket wound was made with a sharp keratome to the depth of Descemet's membrane; into this wound the bacterial emulsion was introduced with a platinum needle. For inoculation of the anterior chamber, the cornea was incised with a Graefe knife, and a large amount of the pure culture of the organism was placed on the surface of the iris with a spatula. The method used for the inoculation of the vitreous cavity was similar to that used for the inoculation of the anterior chamber; the undiluted culture was injected into the vitreous. The day following the inoculation into the cornea of the rabbit a great amount of purulent discharge was found in the conjunctival sac. The wound of the cornea was infiltrated and covered with some whitish exudate which could not be wiped off; the other parts of the cornea were clear. On the third day after inoculation, the purulent discharge increased in amount, but the conjunctiva showed no remarkable redness or swelling. The area of infiltration of the inoculated area in the cornea was the same size as formerly, but its center had become necrotic and was easily removed. The other parts of the cornea became grayish. The anterior chamber was free from pathologic changes. A large number of pneumobacilli were present in the conjunctival discharge. Histologic examination showed an ulcer involving two thirds of the thickness of the cornea. Panophthalmitis developed as a result of inoculation of the anterior chamber and the vitreous cavity. Bursuk¹⁰ and Pivovarov¹¹ inoculated the rabbit's cornea with the pneumobacillus, and the cornea subsequently showed a grayish disciform opacity, superficially situated, slightly elevated and surrounded by numerous tiny areas of infiltrate.

Terson and Gabrielidès¹² claimed that the organism is frequently present in the conjunctivae of patients with ozena and is often responsible for infections of the eye following epithelial injury and operations. Cuénod,¹³ Uhthoff¹⁴ and Axenfeld¹⁵ stated that they did not agree with this statement; they said that not only did they

9. Perles, M.: *Virchows Arch. f. path. Anat.* **140**:231, 1895.

10. Bursuk, G.: *Zentralbl. f. d. ges. Ophth.* **29**:94, 1933.

11. Pivovarov, V.: *Sovet. vestnik oftal.* **1**:508, 1932.

12. Terson, A., and Gabrielidès, A.: *Arch. d'opht.* **14**:488, 1894.

13. Cuénod, A.: *Arch. d'opht.* **14**:495, 1894.

14. Uhthoff, W.: *Arch. f. Ophth.* **42**:1, 1896.

15. Axenfeld, T.: *Die Bakteriologie in der Augenheilkunde*, Jena, Gustav Fischer, 1907, pp. 222-226.

not observe this organism in the conjunctivae, but they noted it only seldom in the pus from the lacrimal sacs of patients with ozena. Axenfeld¹⁵ was only occasionally able to cultivate this organism from the conjunctivae of catarrhal eyes, but he recovered it abundantly from the conjunctivae of eyes with chronic conjunctivitis associated with chronic dacryocystitis. Gourfein¹⁶ observed the micro-organism in pus from an eye with dacryocystitis in four of forty cases in which there were no nasal lesions. Sattler¹⁷ discovered it in pus from the lacrimal sac. Etienne¹⁸ recovered it from the discharge of an eye in a case of dacryocystitis associated with corneal ulcer. Brayley, Eyre and Kreseritzki,¹⁹ Gonin,²⁰ Zia,²¹ Derby²² and Hirota²³ encountered it in cases of conjunctivitis, acute or subacute, which, according to Derby²² and other authors, is very resistant to any local treatment. No epidemic conjunctivitis caused by this organism has been recorded, nor has inoculation of human eyes been reported. The organism was recovered from the pus from an inflamed chalazion by Maklakow,²⁴ Cosenza²⁵ and Henriksen.²⁶ The latter, moreover, obtained positive agglutination and complement fixation reactions from the blood of his patient.

Groenouw²⁷ once noted the pneumobacillus in abundant numbers in an eye with almost healed blennorrhoea neonatorum. He considered this organism merely an agent in the production of a mixed infection in this case. He isolated it from his patient and inoculated it into the cornea of a rabbit, the eye of which subsequently showed a whitish infiltrate in the cornea without hypopyon. Then he instilled a pure culture of this organism into the conjunctival sac of another rabbit; the conjunctiva was purposely injured before the inoculation. Two days after the inoculation the conjunctiva showed very slight redness, while the cornea showed a grayish infiltrate in its lower part. Therefore, he considered this organism as being more pathogenic for the cornea than for the conjunctiva.

16. Gourfein: *Rev. méd. de la Suisse Rom.* **22**:119, 1902.

17. Sattler, H., in Axenfeld,¹⁵ p. 226.

18. Etienne, G., in Axenfeld,¹⁵ p. 226.

19. Brayley, Eyre and Kreseritzki, in Axenfeld,¹⁵ p. 224.

20. Gonin, J.: *Rev. méd. de la Suisse Rom.* **19**:89, 1899.

21. Zia, in Axenfeld,¹⁵ p. 224.

22. Derby, G. S.: *Am. J. Ophth.* **22**:1, 1905.

23. Hirota, K.: *Ueber die Mikroorganismen im Sekret der Conjunctivitis catarrhalis und im Bindehautsack des gesunden Auges*, Inaug. Dissert., Halle, C. A. Kaemmerer & Co., 1901.

24. Maklakow, A.: *Arch. f. Augenh.* **43**:10, 1901.

25. Cosenza, G.: *Boll d'ocul.* **8**:1090, 1929.

26. Henriksen, S. D.: *Norsk mag. f. lægevidensk.* **94**:1248, 1933; *Zentralbl. f. d. ges. Ophth.* **31**:150, 1934.

27. Groenouw, A.: *Arch. f. Ophth.* **52**:51, 1901.

The pneumobacillus has been reported by many authors as being the causal agent of corneal lesions. Stoewer²⁸ reported a case of deep corneal ulcer caused by this organism following trauma. The eye presented the clinical picture of atypical serpent ulcer, which healed rapidly without perforation. Gourfein¹⁶ observed the organism in a case of typical serpent ulcer. Gonin²⁹ observed it in two of ten cases of catarrhal ulcer. Basso²⁹ recovered it from material from a corneal ulcer and from material from the nose of a patient with ozena. Loeb³⁰ observed the organism in scrapings from the corneal ulcer in a child with keratomalacia; this could be considered only as a secondary infection. Wopfner³¹ reported a case of metastatic panophthalmitis following croupous pneumonia in which the pneumobacillus was observed in both the eye and the lung.

A case of keratitis caused by the pneumobacillus is reported here because of the rarity of the disease and because of the peculiar clinical picture.

REPORT OF CASE

History.—A Chinese man aged 26 years was admitted to the ophthalmologic service of the Peiping Union Medical College Hospital on Oct. 23, 1936, because of a whitish spot at the lower periphery of the left cornea. His eyes had been normal until about twenty days before his admission to the hospital, when this whitish spot, associated with a small amount of mucoid discharge and slight local discomfort, was noticed. It had remained stationary in size.

Ophthalmic and General Examination.—The right eye was found to be normal except for moderate amblyopia. The left eye showed slight congestion of the bulbar and the palpebral conjunctiva, an inflamed chalazion in the lower lid and an interesting corneal lesion: a sharply defined whitish spot, measuring about 3 by 1.5 mm., was located near the limbus at 6:30 o'clock. The surface of the lesion was slightly elevated, dry and granular. Slit lamp examination revealed that the lesion occupied only the superficial layers of the cornea and the epithelium in the area of the lesion was absent. There were two small, roundish, whitish patches, each about 0.5 mm. in diameter, one on each side of the lesion, with fine opacities in their neighborhood. Superficial vessels were growing into and around the lesion. A number of grayish dots located in the epithelium and staining with fluorescein were seen scattered over the periphery of the cornea (fig. 1). Otherwise the left eye was normal. Vision of the eye was 6/6 and the patient was able to read Jaeger's test type 1. The lacrimal secretion was found to be present in normal amounts by Schirmer's method. The corneal sensation and the dark adaptation of each eye were normal. The lacrimal passages on each side were patent. No lesion was found in the nose by the otolaryngologist. Physical examination revealed nothing important. The Wassermann reaction of the blood was negative.

On October 24, the day after admission, a portion of the lesion was scraped off for microscopic examination. It consisted of cellular debris and gram-negative

28. Stoewer, P.: *Klin. Monatsbl. f. Augenh.* **45**:560, 1907.

29. Basso: *Clin. ocul.* **4**:1479, 1903.

30. Loeb: *Zentralbl. f. Bakt.* **10**:369, 1891.

31. Wopfner: *Klin. Monatsbl. f. Augenh.* **43**:402, 1905.

bacilli. After scraping, a shallow depression with a smooth surface was left. Two days later the depression had filled in, and the lesion assumed its original appearance.

In order to rule out vitamin A deficiency, carotene was given, without any effect.

Bacteriologic Examination.—The gram-negative bacilli which were recovered from material from the corneal lesion, from material from normal parts of the left cornea and from material from the chalazion in the left lower lid were identified as Friedländer's pneumobacilli. Cultures of the scrapings from the conjunctiva and the cornea of the right eye showed the same bacilli, although there the colonies were scanty. A smear culture of material from the nose gave a luxuriant growth of the same organism. To rule out a fungus as a possible causative agent, several Sabouraud dextrose agar plates were inoculated with material from the lesion, but no growth was obtained.

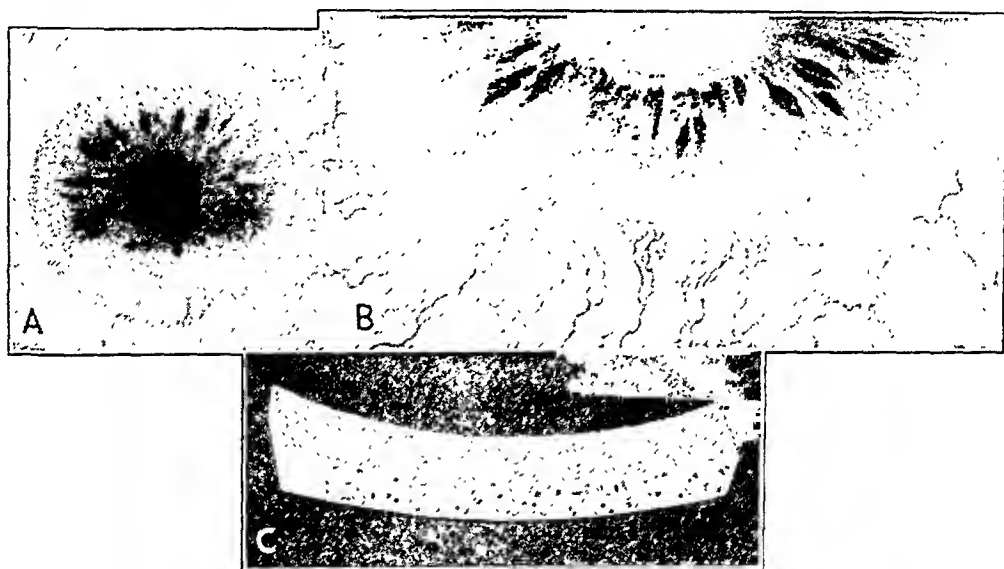


Fig. 1.—*A*, the corneal lesion as seen with the loupe; *B*, the corneal lesion as seen with the slit lamp; *C*, epithelial infiltrations (stained with fluorescein) at the periphery of the cornea.

Experiments on Animals.—Perles' ⁹ technic was applied. One guinea-pig and two mice were inoculated intraperitoneally with an emulsion of the pure culture; these animals died of peritonitis twenty-four hours after the inoculation. The abdominal fluid showed a positive culture of the pneumobacillus.

On November 13 an intracorneal inoculation was made in one rabbit. The next day the cornea showed dense infiltration along the track of the wound. On the third day the infiltration became denser and more widespread. The corneal epithelium became edematous. On November 17, four days after the inoculation, the condition of the cornea began to improve. The edema of the epithelium was diminishing, and the infiltration became demarcated (fig. 2 *A*). On November 18 the top of the infiltrate broke off; there a small ulcer developed, while the epithelium over the rest of the infiltration remained intact. On November 19 both superficial and deep blood vessels were growing toward the infiltration. On November 23 the vessels had reached the area of infiltration, which meanwhile had become much smaller. The ulcerated part was gradually becoming covered with epithe-

lium. On November 26 the area of infiltration was still smaller, and the blood vessels had decreased in number (fig. 2 *B*). The improvement continued until December 4, when only a small scar remained in the middle layer of the cornea. Culture of material from the infiltration showed the pneumobacillus.

Inoculation was made into the anterior chamber of another rabbit on November 13. The next day the aqueous was opaque, and the iris was covered by exudate. On November 15 the deep layers of the cornea were infiltrated, and the iris was very hyperemic. On November 17 the condition of the iris was becoming worse, but on November 19 the exudate began to be absorbed. On November 20 the exudate in the chamber had decreased so markedly that the iris was entirely free from it. The pupillary area was, however, still covered by some exudate. On November 23 the pupillary exudate also disappeared. The condition continued to improve up to December 4, when the eye was restored to its normal state.

Inoculation was made into the vitreous cavity of four rabbits. All of them showed the following conditions: Chemosis of the bulbar conjunctiva occurred on the second day after the inoculation. The aqueous became cloudy and the iris hyperemic. Two or three days later, exudate was found in the anterior chamber. Grayish exudate and sometimes hemorrhages were visible in the vitreous. After

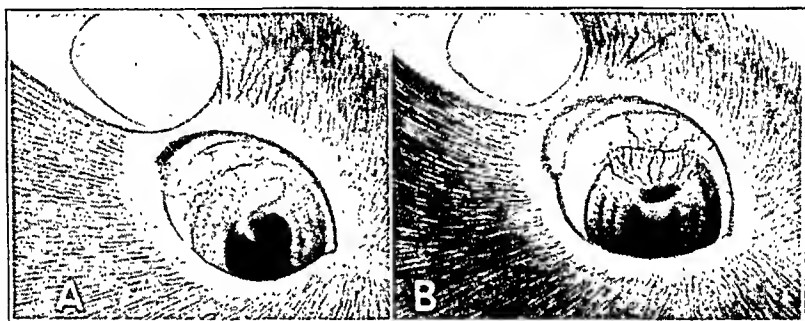


Fig. 2.—*A*, infiltration of the rabbit's cornea following inoculation of the pneumobacillus; *B*, healing stage of the experimental corneal lesion in the rabbit's eye.

six or eight days the chemosis and the exudate in the anterior chamber disappeared, but the opacity in the vitreous was persistent and even increased in density. Detachment of the retina was found in all the eyes.

Treatment and Outcome.—After the investigations were finished, the corneal lesion of the patient was treated by removal of the opaque layer with a keratome, which was followed by diathermic cauterization. The defect produced was superficial and healed promptly, leaving a small vascularized scar.

COMMENT

When the corneal lesion was seen for the first time, it presented a clinical picture which led one to consider keratomycosis, xerosis corneae or keratoconjunctivitis sicca. Repeated failure to observe fungi ruled out keratomycosis. The patient had no local or general signs of vitamin A deficiency. The dark adaptation was normal, and no improvement followed the administration of carotene (vitamin A preparation). Thus the possibility of xerosis was eliminated. Since the lacrimal secretion was normal, keratoconjunctivitis sicca could also be excluded.

It was not until the pneumobacillus was recovered from the lesion and the results of the subsequent inoculation experiments were positive that it was established as the causative agent. The conclusion that the disease was caused by the pneumobacillus is borne out by the following facts:

1. The pneumobacillus was the only organism observed in the corneal lesion.
2. It was virulent enough to produce lesions in experimental animals, from which it could be recovered.
3. Material from the diseased eye gave a much richer cultural growth of the organism than material from the normal eye.
4. According to Gourfein,¹⁶ the organism is rarely seen as a saprophyte in the conjunctival sac.

SUMMARY

A case of superficial keratitis caused by Friedländer's pneumobacillus is reported.

The pneumobacillus was recovered from the conjunctiva, the cornea and the inflamed meibomian gland of the affected eye, from the conjunctiva of the other eye, which was clinically normal, and from the nose.

Inoculation of the organism into the corneas, the anterior chambers and the vitreous cavities of experimental animals produced severe lesions.

The clinical picture of the corneal lesion was peculiar, suggesting keratomycosis, xerosis or keratoconjunctivitis sicca rather than an infection with a virulent micro-organism.

Clinical Notes

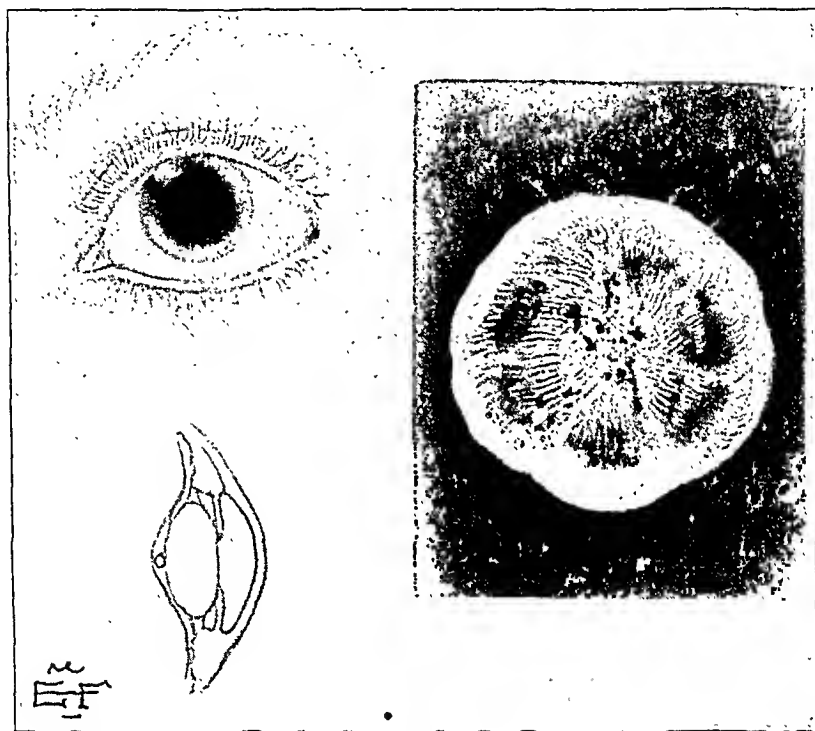
CYSTLIKE REMAINS OF THE VASA HYALOIDEA PROPRIA

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REPORT OF CASE

A case in which cystlike remains of the vasa hyaloidea propria were observed is reported as follows:

R. L., a boy 13 years of age, was referred for examination because of convergent concomitant squint of the left eye of 20 degrees. Vision of the right eye



Drawings showing appearance and location of the cyst.

was 20/20, and that of the left eye was 20/100 and was not improved. The pupils, the tension and the fundi were normal. With direct illumination, there was seen to be present on the posterior pole of the left lens a white opacity resembling a posterior polar cataract. With the slit lamp the detailed examination of this opacity revealed:

In the retrolental space and attached by a strand of pigment slightly nasal to the posterior pole of the left lens was a globular, semitransparent cyst, about 1 by 0.5 mm. in diameter. It was sharply circumscribed but not entirely spherical. Scattered in this cyst were a number of fine particles of brown pigment. Strands running through the cyst gave it a multilocular appearance. Extending from the edges of the cyst, as well as from the posterior surface of the lens, were the

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spiral and corkscrew remains of the vasa hyaloidea propria. The retrolental space did not contain cells or elements other than those just mentioned and was relatively very deep.

COMMENT

The congenital anomaly just described is not a common one.

Lavery¹ reported a case of cyst of the vitreous back of the retrolental space following an injury. Vision was 20/20. He did not describe the appearance of cyst or give other details.

Koby,² in his text "Slit-Lamp Microscopy of the Living Eye," included a drawing of a transparent pigmented spherical body in the retrolental space. In the legend accompanying the drawing he stated that this spherical body was between two layers of the posterior capsule of the lens. But in the description he mentioned that it was attached to the posterior capsule of the lens. It was not connected with the hyaloid artery, though that was present.

In an article published later Koby³ again described the case previously reported and added another. In this he described as a relic of the hyaloid artery the anomaly observed in the form of a whitish pear-shaped mass attached by a network of vessels to the posterior capsule of the lens.

Bernard Samuels⁴ in a paper on opacities of the vitreous spoke of spheres of tissue of the vitreous, with or without pigment. Their origin was either from broken-down coagulated stroma or from verrucae of the lamina vitrea which had worked their way through the entire thickness of the retina. However, the anomaly present in my case, though it can be spoken of as a cyst of the vitreous, is not grouped under that classification.

1. Lavery, F. S.: Cyst in Vitreous Humor, Tr. Ophth. Soc. U. Kingdom 52:578, 1932.

2. Koby, F. E.: Slit-Lamp Microscopy of the Living Eye, ed. 2, Philadelphia, P. Blakiston's Son & Co., 1930.

3. Koby, F. E.: Biomicroscopic du corps vitré, Bull. et mém. Soc. franç. d'ophth. 45:15, 1932.

4. Samuels, Bernard: Opacities of the Vitreous, Tr. Ophth. Soc. U. Kingdom 50:414, 1930.

RAYNAUD'S DISEASE WITH INTERMITTENT SPASM OF THE RETINAL ARTERY AND VEINS

Follow-Up Report of a Case

W. M. CARPENTER, M.D., AND E. W. CARPENTER, M.D.
GREENVILLE, S. C.

Todd¹ in an article published in 1912 suggested that vascular spasms are not always spastic but may be intermittent and are not always fatal to the parts involved.

"According to the present state of our knowledge, angiospasm alone can never lead to gangrene and can only be regarded as a secondary

1. Todd, T. W.: The Vascular Symptoms in "Cervical" Rib, Lancet 2:362, 1912.

factor in its production.”² This is not in accordance with the usual conception of Raynaud’s disease. One would think that spasm of the central artery would lead to death of the retina, because the retina is entirely dependent on the central artery for nourishment. In visualizing the sequence in the pathologic changes of Raynaud’s disease one must first settle the question, Is the spasm spastic or intermittent? In reviewing the subject we have concluded that the usual state of affairs is intermittence and that these attacks are not always fatal to the part involved. Sometimes function is distorted, and at other times organic dissolution takes place.

In the case which we are reporting there is functional destruction without complete dissolution of the retina. A preliminary report of this case was published in the *ARCHIVES*.³ The patient was first seen by Dr. E. B. Gray, of Spartanburg, S. C., on Oct. 23, 1936, and was seen last by us on Aug. 6, 1937.

On the patient’s first visit to us, on Oct. 26, 1936, the right eye was blind except for dim perception of bright light. The pupil was normal in size and did not react to direct light but did react to indirect light. The binocular ophthalmoscope revealed that the retina was pale and moderately blurred. Between the disk and the temporal side were numerous superficial patches of striate hemorrhage. All the arteries appeared as white streaks; three secondary veins contained small segments of blood, and there was a red spot in the center of the macula. While we were meditating on this picture and wondering why the segments of blood were in the veins and why the retina was not whiter and more atrophic, as the patient had been blind for two or three months, a primary artery suddenly shot full of blood to the point where it divided. Then another arterial trunk and another showed this phenomenon in lightning-like rapidity, and the appearance suggested the spokes of a cart-wheel. The next change in the picture was a similar filling of the secondary arteries and then of the veins. This phenomenon was repeated every few moments for over two hours. We demonstrated it to several physicians.

Two weeks after the patient’s first visit all the retinal vessels were full except one small artery below the macula. The intermittent filling and emptying still occurred but at longer intervals. The filling of the primary arteries was followed by filling of the secondary twigs and of the veins in such a rapid sequence that it is difficult to measure the interval in time. The striate hemorrhage was subsiding. This denoted that the metabolism of the retina was active. But the eye was blind, which meant that the intermittent absence of blood had caused the death of the ganglion cells. The empty artery under the macula suggested a sectional spasm. The segments of blood in the veins on the first visit also suggested a sectional spasm of the veins. This raises the question whether the spasm was an impulse arising in a central vessel and proceeding like a wave or whether it was an impulse projected

2. Tice, Frederick: *Practice of Medicine*, Hagerstown, Md., W. F. Prior Company, Inc., 1927, vol. 10, p. 650.

3. Anderson, R. G., and Gray, E. B.: Spasm of the Central Retinal Artery in Raynaud’s Disease: Report of a Case. *Arch. Ophth.* **17**:662 (April) 1937.

over the whole area instantaneously. We believe that the wave impulse was sustained by the phenomena in the case.

It was interesting to note the movement of the segments of blood which were trapped in the primary vein stems. As soon as the primary arteries dilated, these segments shot forward with great rapidity, showing that the veins dilated almost synchronously with the arteries. When the patient was last seen, on Aug. 6, 1937, the following picture was noted: The disk was snow-white. The cribriform plate was conspicuous. The primary arteries had tiny central red streaks, and their walls were visible. No secondary arteries were visible. The veins were about one-third the normal size, were pale and contained blood; secondary branches were visible. The retina was paler than normal. The macula showed a red center; macular markings were absent, and the macular region was surrounded by a silver reflex ring. This condition demonstrated that there was not complete spasm of all the retinal vessels and that, while the function of the retina had been abolished, organic dissolution was not complete.

When Raynaud's disease attacks the extremities, dissolution is sooner or later complete.

The patient had fifteen doses of acetylcholine. At this time there were several painful petechial spots on the tip of the little finger of the left hand.

What is the explanation for the continued physical integrity of the retina? It must be that the fine central arterial line represented blood, and this was sufficient to sustain the status quo. The obliteration of the circulation was incomplete because the spasm impulse was insufficient to obliterate completely the arterial caliber up to this time.

The main reason for this contribution is the observation of the retinal vascular spasm over such a length of time.

Because the phenomena seen in this case are unique, we believe they should be recorded.

Ophthalmologic Review

THE CATARACTOUS LENS

EXPERIMENTAL AND CLINICAL STUDIES

I. S. TASSMAN, M.D.

PHILADELPHIA

After the earlier investigations of the lens proteins by Mörner, Jess and others, the study of the chemical structure of the lens and analysis of the fractions and their properties continued to be of great interest to others in attempting to explain the development of senile cataract.

Among the later studies of the chemical structure of the lens were those made by Krause,¹ who found that the crystallins corresponded to albumins, with the percentages of arginine, histidine, lysine and tyrosine present somewhat higher than those obtained by Jess. He also found a percentage of cysteine in the normal lens lower than the percentages reported by earlier investigators. Krause also studied the molecular weight of the lens proteins.

The weight and the nitrogen and water content of the crystalline lens were investigated by P. W. Salit² and J. Kubik.³ Salit found that the water content of the normal lenses of cattle decreases with age. The weight of the lenses of calves increases with age. Kubik found that with the formation of cataract in the human lens there is a gradual decrease in the weight of the lens, and the more mature the cataract, the greater the loss of weight.

THE LIPIDS

The lipids of normal and cataractous lenses were investigated by Salit,⁴ Krause⁵ and others. It was agreed by most investigators that

1. Krause, Arlington: Chemistry of the Lens: Composition of Beta Crystallin, Albumin (Gamma Crystallin) and Capsule, *Arch. Ophth.* **9**:617 (April) 1933; Chemistry of the Lens: Relation of Anatomic Distribution of Lenticular Proteins to Their Chemical Composition, *ibid.* **10**:788 (Dec.) 1933.

2. Salit, P. W.: Biochemical Investigation of Nitrogen, Weight and Water Content of Crystalline Lenses, *Arch. Ophth.* **5**:623 (April) 1931.

3. Kubik, J.: *Arch. f. Augenh.* **102**:675 (Feb.) 1930.

4. Salit, P. W.: Biochemistry of the Aqueous, Lens and Vitreous, *Arch. Ophth.* **4**:374 (Sept.) 1930; Chemical Studies of the Lipids of the Normal Animal Lenses, Cataractous Human Lenses, and Blood of Patients with Cataract, *ibid.* **5**:354 (March) 1931.

5. Krause, Arlington: Chemistry of the Lens: Lipids, *Arch. Ophth.* **13**:187 (Feb.) 1935; Biochemistry of the Eye, *ibid.* **15**:522 (March) 1936.

the values for cholesterol and lecithin varied little in the normal lens at any age. In cataractous lenses, however, the cholesterol content was found to be above normal and the lecithin content at the upper limit of normal. Salit agreed with O'Brien and Myers that the cholesterol content of the blood was somewhat above normal also. Michael and Vancea had also previously produced experimental hypercholesteremia in rabbits which were fed naphthalene. They felt that this condition was the result of a reaction of the organism in combating a poison. Salit and O'Brien⁶ also analyzed the amount of cholesterol in the various stages of cataract and found in one hundred and four cases that the variations were more or less the same in all stages and that the lenses as a group did not differ in cholesterol content from normal lenses of similar age. They did find that in the normal lens of a 16 year old girl the cholesterol content was less than that found in the lens of an 86 year old woman. In the latter, however, the content was the same as the average for cataractous lenses of patients of similar age.

THE CALCIUM CONTENT

The calcium content of the normal and of the cataractous lens has been studied by Salit,⁷ Kirby,⁸ Grabar and Nordmann,⁹ Adams¹⁰ and others. It was found that normal lenses of persons of different ages vary little in their calcium content. In cases of senile cataract, however, the calcium content of the lens was found to be greatly increased. This was considered to be the result of a purely local disturbance, since most of the investigators found no significant deviations of the calcium content of the serum in patients with cataract.

Kirby,⁸ who did an enormous amount of work on the subject, also confirmed the finding of increased amounts of calcium in cataractous lenses. He considered that this increase was a secondary change and not a primary factor, especially since no increase in the calcium content had been found in the early stages of cataract. Kirby also investigated

6. Salit, P. W., and O'Brien, C. S.: Cholesterol Content of Cataractous Human Lenses, *Arch. Ophth.* **13**:227 (Feb.) 1935.

7. Salit, P. W.: Calcium Determinations on Cataractous Human Lenses, *Am. J. Ophth.* **13**:1072 (Dec.) 1930; Calcium Content and Weight of Human Cataractous Lenses, *Arch. Ophth.* **9**:571 (April) 1933; Etiology and Chemical Nature of Cataractous Lenses, *Am. J. Ophth.* **14**:523 (June) 1931.

8. Kirby, D. B.: Calcium in Relation to Cataract: In Vitro, *Arch. Ophth.* **5**:856 (June) 1931.

9. Grabar, P., and Nordmann, J.: *Compt. rend. Soc. de biol.* **112**:1534 (May 2) 1933.

10. Adams, D. R.: Rôle of Calcium in Senile Cataract, *Biochem. J.* **23**:902, 1929.

the calcium level of the serum in cases of senile cataract and found no variations according to age, sex, the type of cataract or complicating ocular or general disease. There was no evidence of calcium deficiency, as far as the values for the blood serum were concerned, in cases of senile cataract. In the study of the endogenous calcium metabolism in cases of senile cataract, the patients were found to be responding normally to the factors influencing the calcium metabolism and were utilizing their calcium properly.

Regardless of these findings, Kirby¹¹ decided to employ parathyroid therapy in these cases. He therefore treated three series of patients with injections of an effective parathyroid extract; he obtained no improvement in the vision, refraction or the objective appearance of the cataracts of these patients.

CATARACTS OF ENDOCRINE ORIGIN

Siegrist¹² advanced the view of the endocrine origin of senile cataract. Löwenstein¹³ stated the opinion that cataract caused by endocrine disturbances is more common than is generally assumed. He expressed the belief that such cataracts in young persons present a characteristic picture of subcapsular shieldlike opacities with arcade-shaped outlines. Against the view of the endocrine origin of cataract is the fact that treatment with the specific hormone fails.

Fischer-Galatz¹⁴ stressed the importance of so-called "puberty cataract," which he said is often overlooked, as in many cases it does not interfere early with acuity of vision. This form of cataract appears only at puberty and is due to a deficiency of the interstitial glands. It can be seen only through the dilated pupil and is composed of small gray patches located in the cortex around the equator of the lens. Fischer-Galatz described the puberty cataract as identical with Vogt's coronary cataract and with the "blue cataract" described by earlier authors. It is always bilateral and familial, becomes denser during the sexual maturity of the patient and develops into complete opacity of the lens during older age, thereby indicating a hormonal deficiency of the glands at puberty. Patients with this condition were said to show signs of sexual impotence and an absence of the sexual desire. Hypoparathyroidism,

11. Kirby, D. B.: Senile Cataract: Use of Parathyroid Extract, *Arch. Ophth.* **5**:754 (May) 1931.

12. Siegrist, A.: Gray Senile Cataract: Its Causes and Non-Operative Treatment, Berlin, Urban & Schwarzenberg, 1928.

13. Löwenstein, A.: The Clinical and Histologic Picture of Cataract of Endocrine Gland Origin, *Arch. f. Ophth.* **132**:224 (April) 1934; abstr., *Arch. Ophth.* **13**:467 (March) 1935.

14. Fischer-Galatz, T.: *Clinique*, Paris **25**:119, 1930.

however, was not detected in them. The hormonal imbalance, because of a disturbance of the interstitial cells and consecutive acidosis, was said to cause an alteration in the lens. With definite and complete evolution of the glands at puberty the destructive process in the cells of the lens comes to an end. If the hormonal balance is not restored in the system during growth, the opacification of the lens will progress. Later, in old age, when the activity of the interstitial cells is naturally depressed, the cataract reaches its maximum.

CATARACTS DUE TO THE ROENTGEN RAYS AND HEAT

Cataracts resulting from exposure to the roentgen rays, radium, ultraviolet rays and infra-red rays have been the subject of considerable study. Peter¹⁵ in 1930 produced permanent lenticular lesions of a posterior axial type of complicated cataract in rabbits by exposing them to 1 erythema dose of the roentgen rays. The opacities became visible one hundred and sixty-five days after exposure, so he concluded that it is necessary to wait five months before a certain dose of roentgen rays can be said to be harmless to the lens. The same was true for radium with the usual 0.5 mm. platinum iridium filter. The smallest dose used was 144 milligram element hours, which produced definite opacities in the lens after five and a half months. Axial portions of the cortex, which contain no nuclei, were apparently more sensitive to the roentgen rays and radium than any other part of the lens. The epithelium of the lens did not seem to be affected by the small doses of the roentgen rays. The cataracts due to the roentgen rays and radium differed from cataracts due to the infra-red rays in that they had a long period of latency.

So-called ray cataracts were said by H. Goldmann¹⁶ to be due to absorption of the heat rays by the iris and their secondary conduction to the lens. Without an absorbing medium in front of it the lens would remain clear. Goldmann showed that the iris of rabbits absorbs about 98 per cent of the infra-red rays and explained that cataract in glass blowers is caused by continued exposure to heat rays which are absorbed by the iris and conducted to the lens. In later experiments, in 1933, Goldmann¹⁷ measured the temperature behind the iris and lens and found that radiations from a furnace raises the temperature. If the radiations were filtered so that only infra-red rays acted on the eye the rise in temperature was slight. He concluded that the rôle played by penetrating infra-red rays was small in comparison with that of the heat

15. Peter, L.: *Arch. f. Ophth.* **125**:428, 1930.

16. Goldmann, H.: *Arch. f. Ophth.* **125**:313, 1930.

17. Goldmann, H.: *Arch. f. Ophth.* **130**:93, 1933.

waves and that a similar increase in temperature behind the iris must take place in laborers who work in front of furnaces. P. Scotti¹⁸ also stated the opinion that the cataract of furnace workers is due to the heat of the rays. Meesmann¹⁹ expressed the belief that the sclerosis of the nucleus and senile opacities in the lens are distinct symptoms of the biologic aging of the patient and senile destruction of the lens, which are factors forming a predisposition to the development of lesions resulting from work in front of furnaces. Vogt,²⁰ in 1933, after considerable research of his own and after studying the subject of furnace workers' cataract, concluded with Hirschberg, Birch-Hirschfeld, von Hess and others that furnace workers' cataract is a cataract caused by rays and not by heat. No rays of the spectrum except penetrating infra-red rays can produce cataract on absorption into the lens without damaging the cornea or iris. Vogt stated that heat emanating from the iris and affecting the lens cannot be adduced as an etiologic factor. Colloidal chemical changes of the albumin of the lens may have a causative effect in connection with short wave infra-red rays. The resemblance of the cataract to the axial type of cataract at the area where the rays strike the lens and the absence of any effect on the lids or other parts of the eyes of those afflicted with fire cataract support this view.

THE OXIDATION-REDUCTION MECHANISM

Goldschmidt found that the oxidation-reduction mechanism depended on the presence of a dialyzable thermolabile constituent, glutathione, and a thermostable constituent, beta crystallin. He also showed that methylthionine chloride could be reduced by the normal lens in the presence of cysteine. Because of its importance in the normal lens glutathione was studied quantitatively by Adams,²¹ Tassman and Karr,²² Gifford,²³ Cordero²⁴ and Krause.²⁵ Adams found the amount in normal ox lens to be about 0.3 per cent of the whole weight of the lens. Tassman and Karr estimated that there is an average of 0.296 per cent of glutathione in the normal pig lens and found that it was entirely absent

18. Scotti, P.: *Ann. di ottal. e clin. ocul.* **58**:963 (Nov.) 1930; **59**:230 (March) 1931.

19. Meesmann, A.: *Klin. Monatsbl. f. Augenh.* **92**:289 (March) 1934.

20. Vogt, A.: *Klin. Monatsbl. f. Augenh.* **91**:721 (Dec.) 1933; **85**:32 (Sept.) 1930; **86**:289 and 295 (March) 1931; **91**:30 (July) 1933.

21. Adams, D. R.: *Brit. J. Ophth.* **14**:545 (Nov.) 1930.

22. Tassman, I. S., and Karr, W. G.: *Glutathione in Crystalline Lens*, *Arch. Ophth.* **2**:431 (Oct.) 1929.

23. Gifford, Harold, Jr.: *Determination of Oxidation-Reduction Mechanism in Lens of Rabbits with Naphthalene Cataract*, *Arch. Ophth.* **7**:763 (May) 1932.

24. Cordero, C.: *Rassegna ital. d'ottal.* **2**:69 (Jan.-Feb.) 1933.

25. Krause, Arlington: *Chemistry of Lens: Composition of Albumoid and Alpha Crystallin*, *Arch. Ophth.* **8**:166 (Aug.) 1932.

in the human lens with mature senile cataract. Harold Gifford Jr.²³ also showed that it was absent in human cataractous lenses, and in normal rabbit lenses he found the average amount of glutathione as expressed in percentage of weight of the lens to be 0.431. Krause²⁵ expressed the opinion that these estimates reported for glutathione in the normal lens were too high, since from his studies he was convinced the lens contained smaller quantities of the substance. However, it was agreed by most of the investigators that glutathione is essential to the normal oxidation-reduction mechanism of the lens, that it is present in a smaller quantity than normal in the lens with cataract and that it is almost entirely absent in the lens with mature cataract. This deficiency, however, was thought to be an accompanying factor in the formation of cataract and not an initial cause.

PERMEABILITY OF THE CAPSULE OF THE LENS

The permeability of the capsule of the lens is another factor which was considered of great importance in the development of cataract. Many stated the belief that an increase of the permeability of the capsule was largely responsible for cataract. It was explained that the increased permeability of the capsule was due to the effect of age on the colloidal membrane. Jonas Friedenwald,²⁶ however, showed conclusively that the permeability of the capsule of the lens decreases with age and also with increase in the molecular weight of the diffusing substances. Sanford Gifford and his co-workers²⁷ later also showed that the normal capsule of the lens is freely permeable to water, electrolytes and substances of fairly high molecular weight, but, like Friedenwald, they found that the permeability of the capsule decreases with age and that it is conceivable that this decrease could prevent sources of nutrition from reaching the lens and thus could hasten death of the fibers of the lens, with resulting cataract. They expressed the opinion that the results of their experiments also invalidated the assumption of Duke-Elder that variations in osmotic pressure or in hydrogen ion concentration were effective in producing cataract, for this was not found to be so in vitro, within a range much greater than that possible in life. Duke-Elder,²⁸ in describing the metabolism of the eye, spoke of four equilibriums, the third of which he defined as a delicate balance

26. Friedenwald, Jonas S.: Permeability of Lens Capsule, with Special Reference to Etiology of Senile Cataract, *Arch. Ophth.* **3**:182 (Feb.) 1930; Permeability of Lens Capsule to Water, Dextrose and Other Sugars, *ibid.* **4**:350 (Sept.) 1930.

27. Gifford, S. R.; Lebensohn, J. E., and Puntenny, I. S.: Biochemistry of Lens: Permeability of Capsule of Lens, *Arch. Ophth.* **8**:414 (Sept.) 1932.

28. Duke-Elder, W. S.: Metabolism of the Eye: Physiologic Aspects, *Arch. Ophth.* **6**:1 (July) 1931; Metabolism of the Eyes: Clinical Applications, *ibid.* **6**:158 (Aug.) 1931.

between the intra-ocular fluid and the lens. The effects of disruption of the forces which maintain this equilibrium constitute one of the factors in the etiology of cataract.

SENSITIVITY TO LENS PROTEIN

Verhoeff and Lemoine in 1922²⁹ described what they called endophthalmitis phaco-anaphalactica, in which they found that about 8 per cent of the patients tested by the intradermal injection of lens protein were sensitive to the substance. This was characterized by a local cutaneous reaction, and in the eyes of those patients affected after extraction of cataract these authors observed characteristic histologic changes. This was later confirmed by several other investigators but was contradicted by Roth. It was advised that these patients be desensitized to lens protein both before and after operation. Burky and Woods³⁰ prepared a lens extract for use in cutaneous tests. In seventy-five normal patients tested they obtained negative results, while in eleven patients with cataract they obtained positive results. When they found that rabbits could not be immunized to whole rabbit lens alone and that rabbits on which needling was repeatedly carried out produced no antibodies, they investigated, with Woodhall, the action of the individual purified crystallin in the homologous species, in 1933.³¹ Their results suggested that alpha crystallin is a true organ-specific substance, is the same in all species and is present in all extracts of whole lens. Beta crystallin and gamma crystallin were considered as a complex and were inert in the homologous series. When combined with alpha crystalline in extract of whole lens they modified the antigenic properties so that in the homologous species those of alpha crystalline were inhibited. This suggested to the authors why in most cases the escape of lens substance through the ruptured capsule is not followed by the development of antibodies of an immune allergic type. Burky³² in 1934 produced endophthalmitis phaco-anaphalactica experimentally in rabbits by intermediary action of staphylococcus toxin, which suggested that the sensitivity to lens in man in some instances at least is caused by the action of a toxin from a focus of infection or by the infection of the eye by toxin-forming bacteria at the time the lens matter is being absorbed after an operation.

29. Verhoeff, F. H., and Lemoine, A. N.: *Internat. Cong. Ophth.* **1**:234, 1922.

30. Burky, E. L., and Woods, Alan C.: *Lens Extract: Its Preparation and Clinical Use*, *Arch. Ophth.* **6**:489 (Oct.) 1931.

31. Burky, E. L.; Woods, A. C., and Woodhall, M. B.: *Organ Specific Properties and Antigenic Power in Homologous Species of Alpha Crystallin*, *Arch. Ophth.* **9**:446 (March) 1933.

32. Burky, E. L.: *Experimental Endophthalmitis Phaco-Anaphylactica in Rabbits*, *Arch. Ophth.* **12**:536 (Oct.) 1934.

DIETARY DEFICIENCY AND THE FORMATION OF CATARACT

During the past five years an enormous amount has been published in the literature concerning the relationship of vitamin deficiency to the development of cataract. Cataracts were produced in rats fed on a diet deficient in vitamin G by Day, Langston and O'Brien³³ and later in albino mice by Langston, Day and Cosgrove.³⁴

Mature cataracts developed bilaterally in ten days in 68 per cent of rats which were fed a diet by Mitchell and Dodge in which lactose was the sole carbohydrate and constituted 70 per cent of the ration.³⁵ Definite cataractous changes were also found in the remainder of the rats. Control animals fed starch, maltose, dextrose or sucrose as the sole carbohydrate failed to show lenticular changes.

Later H. S. Mitchell reported the production of cataract in rats fed a diet of galactose. Yudkin and Arnold³⁶ also produced lenticular changes in albino mice which were fed a diet of 70 per cent lactose for from seventy to ninety days. With a diet of 50 per cent galactose these authors produced cataract in from eleven to fourteen days. In all these animals the nucleus showed the opacity first. With older animals which were fed a diet containing 50 per cent galactose, opacities in the lens appeared in about twenty-one days. In five weeks two of the animals showed definite mature cataracts. In contrast to the younger rats, the older animals showed cortical cataracts.

In commenting on the relationship between galactose or lactose and calcium, Yudkin and Arnold suggested that the presence of these sugars in the intestines may increase the absorption of calcium so that there would not be enough of this element present to combine with foreign substances which might have a toxic effect on the lens when absorbed. It was also mentioned that, aside from the possible effects of these sugars on the calcium metabolism, there is a possibility that the ocular lesion is the result of direct injury because of the presence of a considerable amount of lactose and galactose in the aqueous. The latter view was maintained by Mitchell, who suggested that galactose finds its way into the aqueous and alters the permeability of the capsule of the lens, thereby disturbing the existing normal ionic equilibrium.

33. Day, P. L.; Langston, W. C., and O'Brien, C. S.: *Am. J. Ophth.* **14**: 1005 (Oct.) 1931.

34. Langston, W. C.; Day, P. L., and Cosgrove, K. W.: *Cataract in Albino Mouse Resulting from Deficiency of Vitamin G (B₂)*, *Arch. Ophth.* **10**:508 (Oct.) 1933.

35. Mitchell, H. S., and Dodge, W. M.: *J. Nutrition* **9**:37 (Jan.) 1935.

36. Yudkin, A. M., and Arnold, Caroline: *Cataracts Produced in Albino Rats on Ration Containing High Proportion of Lactose or Galactose*, *Arch. Ophth.* **14**: 960 (Dec.) 1935.

VITAMIN C DEFICIENCY

During the past two years vitamin C has received a great deal of attention and has been shown to bear considerable relationship to the formation of cataract. Vitamin C, or cevitamic acid, has been shown to be present in considerable quantity in the normal lens. In 1933 von Euler and Martius³⁷ showed that cevitamic acid reduced methylthionine chloride and all other substances reduced by glutathione and cysteine, and was formerly included in the estimations of these substances in the normal lens. These authors were able to estimate the amount of cevitamic acid independently at p_H 2.5 and revealed that about one fifth of the total reduction power of the bovine lens was due to vitamin C. They examined two clear human lenses from a man 30 years of age and found that the cevitamic acid accounted for 28 per cent of its power of reduction. It was significant that no vitamin C was found in the cataractous lens. At the same time Birch and Dann³⁸ stated that cevitamic acid has always been previously estimated as glutathione in the iodine titration. They suggested that the two may be linked factors in one system of oxidation in the animal cell. The vitamin C content of the lens was investigated also by Nordmann and van Wien,³⁹ Monjukowa and Fradkin,⁴⁰ Müller and Buschke⁴¹ and others.⁴² All agreed that vitamin C decreases in amount with age and is considerably reduced in quantity or nearly absent in a lens with cataract.

H. K. Müller⁴³ found that on feeding naphthalene to rabbits an acceleration in the oxidation of vitamin C in the aqueous took place. By the administration of large doses of cevitamic acid intravenously he was able to prevent the action of naphthalene in causing an increase in this rate of oxidation.

Bellows,⁴⁴ who, like others, found that the quantity of vitamin C was greatly reduced or entirely absent in the lens and aqueous of

37. von Euler, H., and Martius, C.: *Ztschr. f. physiol. Chem.* **222**:64, 1933.

38. Birch, W., and Dann, J. W.: *Nature*, London **131**:469, 1933.

39. Nordmann, J., and van Wien, H.: *Bull. Soc. d'opht. de Paris*, March 1934, p. 136.

40. Monjukowa, N. K., and Fradkin, M. J.: *Arch. f. Ophth.* **133**:328 (Jan.) 378 (Feb.) 1935.

41. Müller, H. K., and Buschke, W.: *Arch. f. Augenh.* **108**:368, 1934

42. Goldmann, H., and Buschke, W.: *Arch. f. Augenh.* **109**:205, 1935.
Campbell, D. A.: *Brit. J. Ophth.* **20**:33 (Jan.) 1936. Nakamura, B., and Nakamura, O.: *Arch. f. Ophth.* **134**:197 (Aug.) 1935. Müller, H. K.: *Arch. f. Augenh.* **109**:434, 1935. Weinstein, P.: *ibid.* **109**:221, 1935. Gurewitsch, A.: *ibid.* **108**:572, 1934.

43. Müller, H. K.: *Arch. f. Augenh.* **109**:304, 1935.

44. Bellows, J.: *The Biochemistry of the Lens: The Origin of Pigment in the Lens*, *Arch. Ophth.* **14**:99 (July) 1935; *Biochemistry of the Lens: Cevitamic*

cataractous eyes, carried out a great many experiments to study the relationship of vitamin C to the formation of cataract. He found that the concentration of vitamin C in the blood of patients with cataract was less than in normal persons. A larger quantity of vitamin C had to be ingested by patients with cataract than by normal persons in order to cause an increase in the content of vitamin C in the blood plasma. He concluded that the reduction in the quantity of vitamin C in the aqueous and lens of cataractous eyes precedes the development of the opacities and is not secondary to it. He also demonstrated that cevitamic acid could be absorbed from the conjunctival sac of a rabbit through the cornea. Returning to the problem of galactose cataract, Bellows attempted to ascertain whether an excess of vitamin C or cystine in the diet would delay or prevent cataract in rats fed on galactose and also whether a decrease in the amount of vitamin C and of cysteine occurs in the lens before the onset of opacities. The result of these experiments showed that the onset of cataract in rats on a galactose diet seems to be somewhat delayed by the intraperitoneal injection of large doses of vitamin C. This was even more clearly demonstrated by the results of the administration of yeast in these cases. In order to prove that the effect of yeast was due to the SH content (cysteine), or to some other factor, Bellows added a small excess of cysteine to a diet rich in galactose and found that the onset of cataract was delayed as compared with the onset in control rats. This indicated that the sulfhydryls in the crystalline lens are lost or destroyed by the presence of galactose and that feeding an excess of these substances results in delay of the death of the fibers of the lens, either because they are replaced or because they are spared. Bellows' next step was to prove further a diminution in the amount of sulfhydryls or of vitamin C in the lens before the appearance of the opacities. Since it was demonstrated that feeding an excess of these substances results in delay of the onset of opacities, he reasoned that if it could also be shown that they diminish in amount before the opacities appear it would be reasonably certain that the loss of these substances is responsible for the formation of cataract. In rats fed on a galactose diet the lenses at the end of three and six days, before any opacities were visible, showed a reduction in the quantity of sulfhydryls—glutathione and cysteine. Since vitamin C was also found to delay the onset of cataract to some degree, Bellows thought the sulfhydryls and vitamin C were interchangeable in carrying out oxidation reduction

Acid Content of the Blood and Urine of Subjects with Senile Cataract, *ibid.* **15**:78 (Jan.) 1936; Biochemistry of the Lens: Some Studies on Vitamin C and Lens, *ibid.* **16**:58 (July) 1936. Bellows, J., and Rosner, L.: Biochemistry of the Lens: A New Proof of the Presence of Vitamin C in the Crystalline Lens, *ibid.* **16**:248 (Aug.) 1936.

in the lens and that as the SH content diminishes, vitamin C, if available, will take over more of this function and keep the lens more or less viable for a time. It was therefore plausible to assume that in man senile cataract could arise similarly, as a result of a sudden or gradual loss of cysteine from the lens which is called on to detoxify various substances, while at the same time there is an insufficient replacement of vitamin C.

In December 1936 Bellows and Rosner⁴⁵ published the results of the preparation of a substance from the crystalline lens of beef eyes which was considered to be glutathione. Up to this time glutathione had not been isolated from the lens in pure form. They obtained 0.2 Gm. from two hundred beef lenses.

45. Bellows, J., and Rosner, L.: Biochemistry of the Lens: Preparation of Glutathione from Crystalline Lens, *Arch. Ophth.* **16**:1001 (Dec.) 1936.

News and Notes

EDITED BY W. L. BENEDICT

UNIVERSITY NEWS

Intensive Post-Graduate Course in Ophthalmology at George Washington University School of Medicine.—The second annual post-graduate course in ophthalmology, given under the auspices of the George Washington University School of Medicine, in Washington, D. C., will be held from April 18 to 23, 1938. According to the preliminary announcement there will be eighteen guest lecturers in addition to the members of the resident staff, who will lecture on clinical subjects. A course in histopathology of the eye by Lt.-Col. J. E. Ash, M.C., U.S.A., Lt.-Col. Frederic H. Thorne, M.C., U.S.A., and Capt. Elbert DeCoursey, M.C., U.S.A., of the Army Medical Museum, is included in the program. The fee for this course will be \$40.

In addition to the regular course mentioned here, a course will be given by the members of the resident staff from April 15 to 17 inclusive. The attendance will be limited to twenty participants. The fee for this course will be \$25, and the names will be filed in order of reception.

The following program for this last named course has been announced as follows:

1. Operations on the eyes of cadavers and of animals, accompanied with illustrated short talks on the operations to be considered.

2. "Ocular Pathology at the Army Medical Museum," by Lt.-Col. J. E. Ash, M.C., U.S.A., Lt.-Col. Frederic H. Thorne, M.C., U.S.A., and Capt. Elbert DeCoursey, M.C., U.S.A.

3. A practical course in the technic of orthoptic training, with short talks on the application of the knowledge of the subject.

Further details may be obtained by writing to the secretary, Miss Louisa G. Wells, 927 Seventeenth Street, N.W., Washington, D. C.

SOCIETY NEWS

Scientific Meeting of the Eye Section of the Philadelphia County Medical Society.—At the meeting of the Eye Section of the Philadelphia County Medical Society held at the Wills Hospital on Dec. 2, 1937, Dr. Thomas Cowan reported a case of bilateral macular coloboma, Dr. Robb McDonald reported cases from the Wills Hospital, Dr. Karl Kornblum gave a lantern demonstration on the "Roentgenologic Aspects of Exophthalmos" and Dr. Gustav Bucky, of New York, gave a lantern demonstration on "Roentgen Versus Grenz Ray Therapy in External Diseases of the Eye."

Treacher Collins Prize.—The council of the Ophthalmological Society of the United Kingdom has instituted a prize of £100 to be awarded triennially for the best essay submitted on a subject selected by the council. This is to be called the Treacher Collins Prize.

The prize is open to qualified medical practitioners of any nationality, but the essay must be written in the English language. The subject for the first award of the prize is "Cerebrospinal Disease and Its Relation to the Optic Nerve."

The closing date for sending in essays for the first award is Dec. 31, 1938. They should be submitted to the honorary secretary, Ophthalmological Society of the United Kingdom, 5 Racquet Court, Fleet Street, E.C.4, from whom also any further particulars can be obtained.

Ophthalmological Society of the United Kingdom.—The annual congress of the Ophthalmological Society of the United Kingdom will be held in London on April 28 to 30, 1938.

The subject for discussion will be: "The Differential Diagnosis of the Causes of Exophthalmos." Mr. R. Foster Moore will consider the ophthalmologic aspects; Mr. T. E. Cawthorne, the otolaryngologic aspects, and Dr. W. Russell Brain, the medical and neurologic aspects.

The annual dinner of the society will be held on Thursday, April 28.

CORRECTION

In the review of Gifford's "Handbook of Ocular Therapeutics," published in the September 1937 issue (ARCH. OPHTH 18:490, 1937), the title was given as "Ocular Therapeutics" and the price given as \$3.25 instead of \$3.75.

Obituaries

WILLIAM LANG

1863-1937

William Lang died on July 13, 1937, at the age of 84. He received his medical education at the London Hospital and was appointed surgeon to the Royal London Ophthalmic Hospital in 1884. He was particularly interested in the diagnosis and treatment of diseases of the eye and was a pioneer in the conception of focal sepsis, as he was one of the first to recognize that iritis had its origin in a focus of inflammation elsewhere in the body.

He was one of the original members of the Ophthalmological Society of the United Kingdom, and many of his articles appeared in the *Transactions of the Ophthalmological Society of the United Kingdom*.

Though handicapped by a marked tremor of the hands, he was a skilful operator and suggested a number of useful instruments, such as a speculum with a device to guard the lashes, two knives to divide anterior adhesions, a lacrimal syringe, a blunt dissector and a scoop. He suggested the insertion of an artificial globe in Tenon's capsule after enucleation.

Lang was a splendid teacher, a hard and conscientious worker and a keen observer. His work was characterized by complete attention to detail, which assured him great success in practice.

His son, Basil, a capable and brilliant ophthalmologist, died at the early age of 47, a few years after being elected to the staff of Moorfields.¹

ARNOLD KNAPP.

1. Lawson, Arnold, cited in Obituary of William Lang, Brit. M. J. 2:189 (July 24) 1937.

PAUL ROEMER

1873-1937

Roemer's early training was different from that of other ophthalmologists as he studied bacteriology with Gaffky and serology with Ehrlich at a time when these new branches of scientific medicine were coming into their own. This unusual preparation opened up for him many new fields in ophthalmology. He was the first to introduce immunologic and bacteriologic investigations into the study of ophthalmologic problems.

Roemer's training in ophthalmology began with Vossius in Giessen from 1897 to 1899 and was continued with Hess in Würzburg from 1901 to 1907. He was appointed to a full professorship in ophthalmology in Greifswald at the early age of 33, where he continued his brilliant investigations. In 1921 he received the ophthalmic appointment in Bonn; he remained here until his death.

His bacteriologic studies were on botulism, bacteria of the conjunctival sac, the varying virulence of pneumococci and the transference of trachoma to animals. His serologic investigations were more important and consisted of studies on the immunity of the aqueous, cornea and vitreous, organ specificity of lens albumin, anaphylaxis of lens albumin, the development of senile cataract, the pathogenesis of sympathetic ophthalmia and immunity to abrin in the treatment of trachoma with jequirity.

Roemer was a man of unusual originality of thought, a true research worker. His investigations were always subjects of importance in the prophylaxis or treatment of diseases of the eye and were carried out with the greatest industry.

ARNOLD KNAPP.

Abstracts from Current Literature

EDITED BY DR. WILLIAM ZENTMAYER

Anatomy and Embryology

HISTOLOGIC SIGNIFICANCE OF THE CAPSULE OF TENON. J. MAWAS, Bull. Soc. d'opht. de Paris, February 1937, p. 110.

Contradictory statements have been made from both a clinical and an anatomic standpoint concerning the ocular aponeurosis. Mawas believes that the greatest difficulty has been due to faulty technic of anatomic studies. After many trials he has evolved the following technic, which apparently avoids confusion: The entire orbit is fixed in a 4 per cent solution of formaldehyde or in Bouin's solution, set in pyroxylin (celloidin) for several months and decalcified in dilute nitric acid colored with a compound of hematin and trinitrophenol, which gives a poppy color to the capsule of Tenon. To obtain an exact idea of the capsule of Tenon it should not be studied as an isolated part, as was done by the anatomist whose name is attached to this membrane. A better method is to connect this study with that of the orbital conjunctiva and other organs of the orbit. In the orbit is a system of partitions formed by conjunctival fibers. This system separates the organs in the orbital cavity and at the same time maintains solidity by periosteal fibers. There is nothing to justify the classic conception of an isolated or separate membrane or capsule. Around the sclera the conjunctival tissue is condensed, and it is intimately adherent to the sclera. Two excellent photomicrographs accompany the article.

L. L. MAYER.

HETEROTOPIC TRANSPLANTATION OF THE OPTIC VESICLES. J. SZEPSENWOL, Compt. rend. Soc. de biol. 125: 609, 1937.

In the axolotl (the larval form of the salamander, *Ambystoma punctatum*) the optic vesicle was transplanted at the site of a previously amputated ear or anterior limb. When the vesicle has the typical orientation (with the lens toward the exterior), characteristic development and differentiation result. Normal form is attained, and the nerve fibers of the retina organize at the disk to form the optic nerve. In atypical orientation, however, development is defective; the eye attains but a quarter of its normal volume, and the elements are hardly differentiated. Contact with the external environment is hence essential for differentiation and the development of nerves.

The optic nerve has a definite affinity for the anterior portion of the brain and will not attach to any other part of the cerebrum, and the presence of the optic vesicle does not affect the course of neighboring cranial or brachial nerves. From the latter, however, sympathetic fibers detach to contact the pigmentary membrane. These fibers arise from a ganglionic mass in intimate relation with the brachial plexus.

J. E. LEBENSOHN.

Biochemistry

THE WATER-BINDING OF THE BRAIN. J. A. VAN HEUVEN and P. F. FISCHER, Brit. J. Ophth. 21: 352 (July) 1937.

From a series of experiments the authors concluded that the white and the gray matter of the brain are capable of binding water and that this water binding is a real *Quellung*.

The capacity for water binding is considerable; it is greater in the white matter than in the gray matter, and the capacity of the white matter of the brain is almost equal to that of the optic nerve. One might say that in these experiments the relation between the optic nerve and the white matter of the brain is once more shown.

W. ZENTMAYER.

Conjunctiva

CONJUNCTIVAL PEMPHIGUS. M. H. WHITING, Brit. J. Ophth. 21: 529 (Oct.) 1937.

The case is of interest because of the beneficial effect of the wearing of a contact glass filled with liquid paraffin. In the right eye this was possible without operative intervention, but in the left eye a lower fornix was first made with a mucous membrane graft from the lip. In the right eye vision improved from ability to count fingers at 1 meter to 6/24 or better, and in the left eye from perception of movements of the hand to 6/60, in three months.

W. ZENTMAYER.

ESSENTIAL ATROPHY OF THE CONJUNCTIVA. E. CUSTODIS, Arch. f. Ophth. 137: 364 (Aug.) 1937.

In 1870 von Stellwag described a disease characterized by apparently primary cicatricial shrinkage and shortening of the entire conjunctiva of each eye. Stellwag named the disease degenerative syndesmitis, whereas von Kries, who observed a similar condition in von Graefe's clinic, introduced the term essential shrinkage, or atrophy, of the conjunctiva. In the years following these two original publications it became almost a general belief that syndesmitis degenerativa was identical with pemphigus.

Custodis has observed and thoroughly studied for seven years one case of what he considers to be true essential atrophy of the conjunctiva. At no time during this period did the patient (an elderly obese woman with mild compensated hypertension, low values for hydrochloric acid in the gastric juice and chronic constipation) show any signs of bullous dermatitis or of vesicular lesions on any of the mucous membranes. The author therefore believes that "essential atrophy of the conjunctiva is a disease by itself which has no relations to the chronic pemphigus of the skin. Essential atrophy of the conjunctiva may go on for years and may or may not be accompanied by manifestations (nonvesicular) on other mucous membranes (mouth, pharynx, larynx). Pathologically, a chronic inflammation prevails in the subepithelial tissue of the conjunctiva, which is followed by hypertrophy of the connective tissue. The tissues of the orbit take part in this chronic inflammation." (In Cus-

todis' case enucleation of one eye became necessary. Because of the small amount of conjunctiva the author performed incomplete exenteration of the orbit.) "During the chronic inflammation and the subsequent shortening of the conjunctiva, vesicle-like structures develop on the surface of the conjunctiva; these are, however, not real vesicles but merely retention cysts developing from accessory lacrimal glands the ducts of which have been blocked by the shrinkage of the conjunctiva. . . . Essential atrophy of the conjunctiva is due to damage done to the subepithelial connective tissue of the eye and other structures by toxins liberated in the alimentary canal. The liberation of toxins has its cause in an endocrine disturbance." The author believes that the measures instituted by him to normalize the function of the bowels (the administration of pepsin and hydrochloric acid by mouth, charcoal and purgatives whenever needed and estrogenic substance) checked the progression of the disease in one eye.

P. C. KRONFELD.

Comparative Ophthalmology

BIOLOGIC STUDY OF THE RETINA OF THE VERTEBRATES. M. L. VERRIER, *Arch. d'opht.* 53: 281 (April); 363 (May) 1936.

This study covers a large number of vertebrate retinas and is illustrated with drawings depicting the great variations found in the rods and cones. One conclusion that the author comes to is that there is an infinite variety of these cells. They can be correlated with the two types of cells, rods and cones, in certain instances, but there are many intermediate types. As the fovea is approached, there is a reduction in the size and height of the visual cells, the droplets of oil becoming more and more indistinct. The visual purple and droplets of oil are not confined to the rods and the cones, respectively. The variation in the form of the visual cells is one of the effects of light. The more or less exclusive occurrence of cones in diurnal animals and of rods in nocturnal animals is not a strict general rule. From the point of view of the dualistic theory of vision, a great deal more work must be done. A microchemical study under varying conditions of illumination, a study of the p_H of the retina and an investigation of the retinal currents might yield valuable information. By such observations alone will it be possible to correlate the form and function of the visual cells.

S. B. MARLOW.

Cornea and Sclera

KERATOPLASTY. R. E. WRIGHT, *Brit. M. J.* 1: 1311 (June 26) 1937.

Wright has developed a simple technic for keratoplasty. A 6 mm. trephine is most useful although a corkborer is almost equally good. No other special instrument is required. A normal anterior chamber is of advantage for the eye receiving the graft. Good grafts can be obtained from eyes blind from glaucoma as well as from those removed because of malignant disease. The recipient's pupil should be small and the donor's large, if possible. Akinesia and anesthesia are established in the usual way.

Preparation for Transplantation.—The site is demarcated on the recipient's cornea by a few rotations of the trephine. Three sutures are placed in the conjunctiva, just off the cornea, in the following manner: from 6 to 12 o'clock, from 7:30 to 1:30 o'clock and from 9:30 to 4:30 o'clock, the free ends being carried back across the cornea to 6, 7:30 and 9:30 o'clock, respectively. The stitches are then pulled free from the demarcated area and the lids closed temporarily.

Trephining the Donor.—In this operation the same trephine is used in a corresponding position on the cornea. Good fixation of the globe is desirable. The disk should be cut away clean as far as possible. Usually a short hinge is left, consisting of a narrow belt of Descemet's membrane, which is cut free with fine, sharp scissors. If a Graefe knife is used it must be plunged deep into the eye and the hinge cut as the knife is withdrawn. The severed disk is received, epithelium side down, on a Volkmann spoon, with the help of a camel's-hair brush, and then placed in isotonic saline solution of a temperature of about 38 C.

Trephining the Recipient.—Great caution is necessary in this operation. One trephines through the cornea as far as possible and then tilts the trephine; the tilting is followed by the escape of aqueous. The hinge will be much larger in this case, often two thirds the circumference of the circle. The disk can be seized with a forceps and the hinge severed at the correct level with either scissors or a knife. A little sterile saline solution is now allowed to flow into the anterior chamber.

The Transplantation.—The graft is lifted with the Volkmann spoon and the camel's-hair brush from the warm saline solution, tumbled into the aperture, and adjusted to its new position by a few touches of the brush. The sutures are then replaced over it in the proper order and tied with the aid of a forceps. Atropine sulfate and iodoform ointment are placed in the conjunctival sac, and both eyes are bandaged.

The patient is kept somewhat quieter than a patient with cataract. The eye is dressed on the third day after the operation, at which time the anterior chamber is usually formed. The sutures are removed on the fifth day, and the instillation of atropine sulfate is continued. On the eighth day the patient is allowed up, and dark glasses are given. The formation of anterior synechiae are to be avoided by all measures at the surgeon's command.

W. F. DUGGAN.

THREE NEW CASES OF DISCIFORM BLOOD STAINING OF THE CORNEA. P. TOULANT and G. MORARD, Arch. d'opht. 53: 241 (April) 1936.

Toulant and Morard carefully observed three cases of blood staining of the cornea from the onset and have been able to study the genesis of this condition with the slit lamp from the very beginning. In all the cases the condition was of traumatic origin. The injury produced hyphemia in the anterior chamber and simultaneously total massive hematoma of the cornea. With the slit lamp it was possible to differentiate only the epithelium of the cornea, as the beam of light penetrated no deeper. It appeared as though the intralamellar spaces were filled with red cells. After a period of from five to nine days a more refringent ring appeared about 2 mm. from the limbus, a sort of condensation ring. Twenty-four

hours later the cornea outside this ring began to clear, the central portion becoming more uniform, obliterating the inner rim of the ring to form the characteristic discoid opacity. This opacity has been reported to last from two months to two years. The authors do not concur in the idea that the condition is a hematic impregnation, because hyphemia and corneal infiltration occur at the same time. They lean to the opinion that it is a true intracorneal hematoma. Its pathogenesis is still in doubt. They believe that its occurrence is independent of hyphemia, changes in the blood and hypertension. In one of the cases hypotension was present. Some experimental work is in progress to attempt to solve this problem by histologic study.

S. B. MARLOW.

CULTURE OF PRESERVED CORNEAL TISSUE. M. A. BAJENOVA, Arch. d'opht. 53: 300 (April) 1936.

Bajenova was able to grow adult rabbit cornea in Carrel mediums. Corneal tissue preserved for ten days at a temperature of -2°C . is capable of growing and preserving its vitality. The elements that grow on culture are the epithelium and the fibrocytes. The preserved cornea grew as well as fresh cornea, the growth differing in neither quality nor quantity.

S. B. MARLOW.

THERAPY OF INTERSTITIAL KERATITIS: TWELVE YEARS' OBSERVATION IN THE DNEPROPETROVSK EYE CLINIC. A. G. KROL, Vestnik oftal. 10: 696, 1937.

The mode of antisyphilitic treatment of interstitial keratitis in the clinic has been as follows: 1. Injections of a solution of mercury instead of injections of neoarsphenamine are given at first, in order to avoid a biotropic reaction; then arsenicals are given, which are followed by injections of bismuth and iodine preparations. 2. Large doses of any medication applied are given. 3. General hygienic measures, such as exposure to sunshine, good nourishment, treatment with the quartz mercury vapor lamp, injections of milk and hot applications, are carried out.

Two hundred and forty-four hospital patients were treated during 1923 to 1935. From 1926 the combined therapy only (mercury, neoarsphenamine, bismuth and iodine, in the order named) was applied. A comparative study was made as to the results obtained from the treatment with one type of medication or with the combined therapy (the results are shown in four tables).

From the results obtained in his extensive experience during many years Krol concludes that combined antisyphilitic therapy has a definitely favorable influence on the course of parenchymatous keratitis, no recurrence being noted. When recurrence does occur, it is a result of insufficient or no treatment. The earlier the treatment is begun, the better the results are; before the age of 15 years the disease seems to run a more favorable course. Krol uses atropine iontophoresis in those cases in which solution of atropine sulfate fails to break down the posterior synechia and to dilate the pupil.

O. SITCHEVSKA.

General Diseases

OCULAR LESION ASSOCIATED WITH POSTOPERATIVE AND GESTATIONAL NUTRITIONAL DEFICIENCY. H. P. WAGENER and J. F. WEIR, *Am. J. Ophth.* 20: 253 (March) 1937.

Wagener and Weir discuss avitaminosis briefly and report several cases. They give the following summary:

"It seems probable that acute optic neuritis, hemorrhages in the retina, paralyzes of ocular muscles, and nystagmus may be caused by dietary or nutritional deficiencies. These deficiencies may develop rather rapidly, especially in the presence of persistent vomiting and the resultant lack of absorption of food."

W. S. REESE.

VISUAL SEQUELAE FROM EPIDEMIC MENINGOCOCCUS MENINGITIS. P. HEATH, *Am. J. Ophth.* 20: 401 (April) 1937.

A study was made to determine clinical residue persisting in epidemic meningococcic infection, especially relating to the visual system, and to compare these findings with other complications, particularly aural. A complete summary of the medical, neurologic, ophthalmic and otologic examinations of sixty-eight patients selected because of a high proportion of complications is given.

W. S. REESE.

OCULOGLANDULAR TULAREMIA. F. A. HAMBURGER, *Arch. f. Ophth.* 137: 419 (Aug.) 1937.

In the fall of 1936 an epidemic of tularemia was observed in the northeast part of lower Austria. Persons were infected through skinning infected wild hares or by eating their meat. About seventy cases of the polyglandular form and five cases of the oculoglandular form were reported to the health authorities. Hamburger made thorough studies of three patients with the oculoglandular type who were admitted to Lindner's clinic. The severity of the conjunctival changes varied. With the exception of the severest forms, which resembled tuberculosis of the conjunctiva, the clinical picture of ocular tularemia was that of Parinaud's conjunctivitis. In cases in which the condition is questionable the diagnosis can be made certain by the agglutination test. The bone marrow of the sternum was found, by inoculation into guinea pigs, to contain the bacillus. Excellent drawings in colors accompany the paper.

P. C. KRONFELD.

General Pathology

FURTHER CONTRIBUTIONS TO OCULAR CHANGES IN BESNIER-BOECK'S DISEASE. R. SEEFELDER, *Arch. f. Augenh.* 110: 415, 1937.

Seefelder describes a case of Besnier-Boeck's disease (Boeck's sarcoid) involving the conjunctival folds. The condition was characterized by follicle formation and small lumps in the conjunctiva. The microscopic changes in the conjunctival follicles corresponded fully to the changes noted in the skin and other organs in this disease. A new observation that the author was able to demonstrate was layer-like calcium concretions in the numerous giant cells present in the follicles.

This picture has apparently been seen heretofore only in tuberculous changes. This fact merits attention in regard to the question of the etiology of the disease.

E. G. SMITH.

CONSTELLATION PATHOLOGY AND OPHTHALMOLOGY. J. STREBEL, *Klin. Monatsbl. f. Augenh.* 97:777 (Dec.) 1936.

Strebel discusses and analyzes the problem of so-called constellation pathology in ophthalmology. It was the topic of a paper by H. Piesbergen (*Klin. Monatsbl. f. Augenh.* 93:765 [Dec.] 1934; abstr., *ARCH. OPHTH.* 14:840 [Nov.] 1935). Strebel adds a number of data from the medical, general and philosophic literature, referring to Aristotle, Leibnitz, Bohr, Kant, Heisenberg, Planck, Kirchhoff and others. He suggests replacing the term constellation pathology with coefficient equation, which term he used in 1915. Great importance is attributed to the causal law, which wrongly has been declared obsolete by some representatives of "atom physics." Strebel stresses the mathematical basis of these considerations and presents his own complicated mathematical equations. He reasons that the constellation of pathologic factors which lead to ocular and other diseases is subject to mathematical laws analogous to the laws governing the various forms of crystals and minerals. Referring to other publications in point, Strebel mentions the discussion "Is the Causal Law Applicable to the Psychic Realm?" by Alfred E. Hoche, professor emeritus of psychiatry at the University of Freiburg, Germany (Hoche, Alfred E.: *Aus der Werkstatt*, Munich, J. F. Lehmann, 1935, p. 101).

K. L. STOLL.

Glaucoma

EXTRA-OCULAR INFLUENCE IN GLAUCOMA (CONSTITUTIONAL FACTORS). F. MASSOUD, *Brit. J. Ophth.* 21:559 (Oct.) 1937.

Massoud recounts the changes found in the circulatory, nervous and endocrine organs in association with glaucoma, as culled from the literature and from his own investigations. He states that on analyzing these findings one cannot fail to see their clear indication of the presence of a toxin or toxins in the body in cases of glaucoma, which constitute the origin of all these changes—their effect on the blood causing its diminished calcium content and other changes; their effect on the blood-forming tissues producing new cellular formation of large mononuclears and other alterations; their effect on the endothelial lining of the capillaries causing increased permeability, and, lastly, their effect on the sympathetic and endocrine systems producing the different states of derangement.

The extra-ocular influences in glaucoma indicate the line of treatment: rest in bed; a restricted diet; free intestinal, cutaneous and renal elimination; the intravenous injection of hypertonic solutions of sodium chloride or concentrated dextrose solution; the occasional use of epinephrine, an alkaloid preparation of ergot, or insulin, and irradiation of the body and of the thyroid.

The increase in the large mononuclear cells of the blood pointed out by the author in conjunction with other early signs may help in the diagnosis of suspected glaucoma.

W. ZENTMAYER.

Lacrimal Apparatus

TECHNIC AND RESULTS OF DACRYOCYSTORHINOSTOMY. H. WEVE and S. K. KENTGENS, *Klin. Monatsbl. f. Augenh.* 98: 195 (Feb.) 1937.

Weve and Kentgens describe in detail the dacryocystorhinostomy performed after Dupuy-Dutemps' method and discuss the preparation, the anesthesia and the instruments. They point out the superiority of this method of suturing the mucous lining to other methods. Postoperative hemorrhage occurred very rarely. In case of postoperative hemorrhage the wound is reopened, and a strip of vioform gauze is inserted through it, but under no condition is insertion made through the nose. The gauze may be removed after forty-eight hours. This operation was performed on children and infants. Passage through the lacrimal canal was obtained within ten days prior to extraction of cataract and other intra-ocular operations. Intrabulbar operations should never be done prior to six weeks after recovery from dacryophlegmon. A fistula should not induce the operator to incise at any but the customary places, because the fistula will heal spontaneously. In tuberculosis of the tear sac, which is rare in Netherlands, extirpation is preferable; when this was followed by roentgen ray treatment healing occurred promptly in the four patients observed and operated on. The presence of swollen preauricular and submaxillary glands facilitates the diagnosis.

In the second part of the paper the authors render an account of the results of dacryocystorhinostomy with suturing of the mucous lining after the method of Dupuy-Dutemps and without suturing after the method of Toti; the former method was employed in 236 cases, and the latter in 129 cases, between January 1934 and September 1936. Perfect functional results were obtained in 97 per cent of the cases of dacryocystitis in which the method of Dupuy-Dutemps was used and in 90 per cent of the cases in which Toti's method was used. The percentage of cures in dacryostenosis was 82 with Dupuy-Dutemps's method and 70 with Toti's method.

K. L. STOLL.

Lens

CORRELATION BETWEEN THE CHANGES IN THE VITREOUS AND THE END-RESULTS OF INTRACAPSULAR EXTRACTION OF CATARACT. E. A. CHURGINA, *Vestnik oftal.* 10: 653, 1937.

A thorough analysis and review of the literature on the causes of prolapse of the vitreous and of the retinal detachment following this is given by Churgina. She studied the anatomic relationship between the posterior capsule of the lens and the anterior hyaloid membrane of the vitreous after having removed the anterior segment of the human enucleated eye. Forty-five hernias of the vitreous (into the anterior chamber) were studied by the slit lamp; some were found to be primary, while the others were secondary or complicated, occurring as a result of injury to the hyaloid membrane. Two colored drawings illustrate a case of secondary hernia of the vitreous which appeared as a bulging mass in the chamber as the result of synechia between the iris and the vitreous, which had been broken down by atropine

sulfate. The histories of six patients in whom detachment of the retina occurred as a result of prolapse or hernia of the vitreous are reported.

Churgina draws the following conclusions:

1. The cause of frequent prolapse of the vitreous lies in the method of the operation.

2. Secondary hernia of the vitreous can occur either during the operation or at a much later period.

3. Pigment in the vitreous, cellular elements, and roughening of the hyaloid membrane are the result of irritation of the ciliary body and of low grade cyclitis.

4. Both prolapse and hernia of the vitreous may cause retinal detachment immediately after the operation or at a remote period.

O. SITCHEVSKA.

Methods of Examination

MAGNIFICATION OF THE IMAGE OBTAINED BY DIRECT OPHTHALMOSCOPIC EXAMINATION. H. LAUBER, *Arch. f. Ophth.* 137:434 (Aug.) 1937.

The magnification of the image obtained through direct ophthalmoscopic examination depends on the distance between the observer and the plane into which he projects the image that he has perceived. Since he has perceived that image without the use of his accommodation, one would, *a priori*, expect that this distance would vary greatly, because there can be no accurate judgment of distance under the conditions of monocular direct ophthalmoscopy. Actually, the amount of resulting magnification does not vary much among observers who have learned to relax their accommodation. Lauber has devised a method by which the degree of magnification can be actually measured. On three emmetropes the horizontal diameter of the blindspot was determined accurately by perimetric examination and the angular measure transposed into the linear measure, the axial length of the eyes being assumed to be 22 mm. By watching a horizontal slit of light of variable length the observer obtained an after-image the length of which was compared to the ophthalmoscopic width of the disks of the aforementioned emmetropes. By varying the length of the slit producing the after-image, the latter could be made as long as the width of the disk. The distances into which the observers were projecting their ophthalmoscopic images were obviously the distances at which the formation of the after-images had taken place, that is the distances between the observer and the slit. Lauber figures that the magnification of direct ophthalmoscopic images varies between ten and eleven and nine-tenths times.

P. C. KRONFELD.

Neurology

AUTONOMIC INNERVATION OF THE EYELIDS AND THE MARCUS GUNN PHENOMENON. F. H. LEWY, R. A. GROFF and F. C. GRANT, *Arch. Neurol. & Psychiat.* 37:1289 (June) 1937.

The authors had previously reported a case of jaw winking which was relieved by section of the motor root of the fifth nerve. The result

of this operation contradicts the two principle theories advanced as an explanation for this phenomenon, namely: (1) that the condition is dependent on a cortical pattern similar to that seen in cases of the Bell phenomenon and (2) that there is a connection between the medullary nuclei of the third, and those of the fifth, cranial nerve. In the operation described the peripheral nerve outside the brain stem was severed, correcting the condition. Neither of the aforementioned theories explain this. However, in the patient under consideration, passive movement of the jaw after operation still produced elevation of the lid, suggesting to the authors that a proprioceptive element was the afferent arc of the reflex, the motor pathway still being unknown. These points suggested that the autonomic nervous system may be a factor in the condition and that the condition simulates the pseudomotor phenomena of Vulpian, Heidenhain and Sherrington.

To establish this similarity the authors sectioned the third nerve in cats, after which they were able to widen the palpebral fissure by injection of certain drugs, such as acetylcholine and nicotine, which stimulate the sympathetic system. To inhibit this response they used epinephrine and atropine. They felt that this demonstrated that sympathetic innervation in cats is responsible for the reaction. That this response did not occur if the first division of the fifth nerve was already severed proved that the efferent motor arc of the phenomenon is conveyed by this nerve. In a future paper they hope to establish the intramedullary connections of the autonomic nerves which are responsible for the response.

R. IRVINE.

Ocular Muscles

SURGICAL RESULTS IN 223 CASES OF HETEROTROPIA. C. BERENS, *Am. J. Ophth.* 20: 266 (March) 1937.

Berens gives the following summary and conclusions:

"1. Of 49 patients (Group I) with varying degrees of esotropia and exotropia, some of whom had alternating strabismus and who received no orthoptic training preoperatively or postoperatively, only 6 percent became heterophoric postoperatively. Heterotropia persisted in 94 percent of the patients.

"2. Of 85 patients (Group II) with varying degrees of esotropia and exotropia, some of whom had alternating strabismus and who were given orthoptic training postoperatively, heterophoria was present in 32 percent (some degree of binocular vision was found in 61 percent).

"3. Of 89 patients (Group III) with varying degrees of esotropia and exotropia, some of whom had alternating strabismus and who received preoperative and postoperative orthoptic training heterophoria was present in 49 percent (73 percent had some degree of binocular vision).

"4. By combining Groups II and III, it is evident that heterophoria following surgery and orthoptic training was present in 70 patients (40 percent); heterophoria for distance or near in 11 patients (7 per-

cent) ; heterotropia persisted in 84 patients (48 percent) ; and there was no record of whether heterophoria or heterotropia was present in nine patients (5 percent).

"5. Forty-seven (70 percent) of 67 patients with alternating esotropia or exotropia developed some degree of binocular vision.

"Twenty-nine (75 percent) of 39 patients who developed alternating squint between the ages of one and four years had some degree of binocular vision following treatment. Prior to operation only 12 patients were known to have had some degree of binocular vision.

"Seven of eight patients who had strabismus before the age of one year developed some degree of binocular vision.

"6. That orthoptic training may be important in the development of normal retinal correspondence postoperatively is suggested by the fact that 25 percent of 126 patients with heterotropia had false projection and following orthoptic training the number was reduced to 10 percent.

"7. Correction of aniseikonia seemed to be a factor in aiding fusion in two of six patients with alternating esotropia.

"8. Of 85 patients with amblyopia, improvement in vision apparently occurred in 53 eyes (62 percent)."

W. S. REESE.

SOME CASES OF PARALYTIC SQUINT. P. G. DOYNE, *Brit. J. Ophth.* 21: 531 (Oct.) 1937.

Doyme has been impressed with the frequency of some muscular weakness as shown by the synoptophore—an incomitance—in cases of congenital or early infantile paralytic squint. In the cases reported the paralysis had been present at least seven years. In four cases the head was rotated in the interest of parallelism, and in the rotated position there was fairly good, though not fully developed, fusion. False correspondence was present in one case. In two patients too young for a synoptophore reading to be taken the condition appears to be developing along the same lines as in the aforementioned four cases. One patient with bilateral paralysis of abduction has acquired complete false correspondence and in this manner attempts to express her binocular sense. One patient with vertical paralysis made no attempt at binocular function and does not posture.

W. ZENTMAYER.

Orbit, Eyeball and Accessory Sinuses

ETIOLOGY OF THE CHRONIC INFLAMMATIONS OF THE EYEBALL. W. WEGNER, *Klin. Monatsbl. f. Augenh.* 98: 15 (Jan.) 1937.

Wegner refers to the research on ocular tuberculosis done at the University Eye Clinic in Freiburg, Germany, by Manz, Axenfeld and Stock. Then he reports data gathered by observation of 600 patients with suspected ocular tuberculosis at the same institution during the last four years. The result was no proof of the theory of the antagonism between pulmonary and ocular tuberculosis. On the contrary, there was a parallelism evident in this respect, as was pointed out pre-

vously by Werdenberg. Wegner frequently found in his patients with suspected ocular tuberculosis tuberculous disease of the bones, skin and glands and also tuberculosis in the family. The diagnosis of ocular tuberculosis is not less contradicted by scarcity of general symptoms than is the diagnosis of tuberculosis of the skin or of the bones. Wegner discusses the favorable effect in some ocular diseases of the parenteral administration of albumin and of endotoxins of bacteria, including those of saprophytic and even pathogenic types. Intercurrent febrile inflammations, such as tonsillar angina, are known to produce similarly favorable results. Their effect, however, is undesirable, or even detrimental, in the various stages of tuberculosis. This fact became evident during two epidemics at the ophthalmic sanatorium in the Black Forest.

In the first epidemic, 43, and during the second epidemic, 27, of 120 patients, contracted a highly infectious type of tonsillar angina. Of these 70 patients, 28 had iridocyclitis, 14 choroiditis and the others keratitis, scleritis, periphlebitis, conglomerate tubercles or inflammatory detachment of the retina; 7 had nonspecific manifestations, in the author's opinion. No change was brought on by the tonsillar angina in 21 of these patients with tuberculous iridocyclitis, while this disease produced a distinct exacerbation, with formation of a hypopyon and diffused opacities in the vitreous, in 7 others. Exacerbations were observed in the patients with keratitis but not in those with periphlebitis or choroiditis. These two epidemics may be termed unintended experiments. They furnished proof for the actual occurrence of ocular tuberculosis, the existence of which has been disputed again recently.

K. L. STOLL.

Pharmacology

THE USE, IN OPHTHALMOLOGY, OF TWO NEW SALTS OF PARA-AMINOBENZOYLDIETHYLAMINO-ETHANOL HYDROCHLORIDE (THE BASE OF PROCAINE HYDROCHLORIDE): THE PHENYLPROPRIONATE AND THE ISOBUTYRATE. A. MONBRUN, J. RÉGNIER and P. JOURDY, *Arch. d'opht.* 53: 349 (May) 1936.

The authors describe two new anesthetics, each of which has an anesthetic strength comparable to that of cocaine hydrochloride and a weak toxicity comparable to that of procaine hydrochloride. In the laboratory, the action of the phenylpropionate of para-aminobenzoyldiethylamino-ethanol hydrochloride on the rabbit's cornea was shown to be eighteen times more anesthetic than that of procaine hydrochloride, before sterilization. After sterilization and aging the difference was even greater. This salt produces good anesthesia when administered by instillation for operations such as those for cataract, but it produces disagreeable burning and vasodilation. For this reason it was discarded for use by instillation. When given by injection it has a very satisfactory action, producing better and more rapid anesthesia than that induced by procaine hydrochloride. A 2 per cent solution is used.

The isobutyrate is used in a 5 per cent solution for surface anesthesia. It is nonirritating and in only a few cases has produced slight conjunctival hyperemia. Its action is more rapid than that of cocaine hydrochloride but also passes off more quickly. No desquamation of the

cornea, dilation of the pupil or change in the intra-ocular tension is produced. It is especially valuable when it must be used frequently for a long time. It can be combined with zinc sulfate.

S. B. MARLOW.

Physiologic Optics

IMPORTANCE OF ANISEIKONIA. E. JACKSON, *Am. J. Ophth.* 20:16, (Jan.) 1937.

This interesting article does not lend itself to abstracting. Jackson points out that patients should be warned that time is necessary for them to become accustomed to glasses which cause a change in the size and form of retinal images. Such changes require changes in cerebral associations of the visual process.

W. S. REESE.

DIFFERENCES IN SIZE OF THE OCULAR IMAGES ARISING FROM ASYMMETRICAL CONVERGENCE. W. HERZAU and K. N. OGLE, *Arch. f. Ophth.* 137:327 (Aug.) 1937.

This paper was read, in abridged form, before the New England Ophthalmological Society on May 23, 1936 (*Am. J. Ophth.* 20:418 [April] 1937). Three types of differences in size of the ocular images can be distinguished: (1) a physiologic type arising from asymmetrical convergence, (2) artificial differences induced by spectacle lenses of different magnifications and (3) the "pathological" differences, which constitute true anisokonia. With regard to the first type mentioned, evidence is presented in the paper which indicates the existence of some type of mechanism that compensates for differences in size occurring when looking to the right or left at near visual range. Experiments on the horopter apparatus show nearly complete compensation of the differences in size in the vertical meridian and partial compensation in the horizontal meridian. These results offer a logical explanation for the fact that the differences in size introduced by asymmetrical convergence do not interfere with reading. Through the action of the compensation mechanism, fusion of the two images of unequal size is accomplished.

P. C. KRONFELD.

Physiology

RESEARCH ON THE RESPIRATION OF THE OPTIC NERVE. D. MICHAÏL and S. BENETATO, *Arch. d'opht.* 53:346 (May) 1936.

Except for the work of Tashiro, no studies of this nature have been done on the optic nerve, although great advances have been made in studies on other nerves. The material was obtained from two injured eyes, five glaucomatous eyes and four eyes with atrophy of the optic nerve. The average figure for the mean consumption of oxygen for the injured eyes was 114 cu. mm. per gram of optic nerve per hour; that for the glaucomatous eyes, 172 cu. mm., and that for the eyes with atrophy of the optic nerve, 197 cu. mm. The increase, Michaïl and Benetato suggest, is partly explained by the activity of the remaining nerve fibers and by the infiltration of connective tissue.

S. B. MARLOW.

Retina and Optic Nerve

SUDDEN OCCLUSION OF RETINAL ARTERIES. A. J. BEDELL, *Am. J. Ophth.* 20: 237 (March) 1937.

Bedell discusses sudden closure of the main retinal artery and reports eight cases, illustrated with photographs of the fundus. He arrives at the following conclusions from analysis of the photographs and fields:

"That there is a definite straight-line field defect, even when the edematous retina presents a crenated border.

"That the macula may be partly encircled and yet central vision be retained.

"That an embolus may be visible at the apex of the region of white retinal edema which coincides with the part of the retina supplied by that particular artery.

"That a field defect suggesting a raphe is present, is readily recognized, and has been frequently recorded.

"The review of the cases here presented shows:

"That the majority of patients have complained of sudden loss of vision without premonitory obscurations.

"That some occlusions are definitely coincident with cardiac disease and others with hypertension.

"That after a vessel has once been occluded it seldom, if ever, reopens, but remains as a visible white line."

He pleads for this combined method of parallel study of photographs and fields.

W. S. REESE.

MECHANISM OF SPONTANEOUS RETINAL DETACHMENT. Y. SUGITA, *Arch. f. Ophth.* 137: 447 (Aug.) 1937.

If the enucleated eyes of animals are put in concentrated salt solutions or if such solutions are injected into the vitreous of enucleated eyes, a retinal detachment develops which, according to Sugita, is analogous to the process of plasmolysis in plant cells. The dehydrated retina cannot maintain its normal shape and position. In the case of spontaneous retinal detachment in man, the liquefaction of the vitreous causes, by the breaking up of larger molecules into smaller ones, an increase of the osmotic concentration which prevails on the inner side of the retina and consequently leads to dehydration and separation of the retina.

P. C. KRONFELD.

A CASE OF A HITHERTO UNDESCRIBED RAPID FORM OF PIGMENTARY DEGENERATION OF THE RETINA ASSOCIATED WITH COMPLETE DEMENTIA. W. STOCK, *Klin. Monatsbl. f. Augenh.* 97: 577 (Nov.) 1936.

Stock refers to a special form of pigmentary degeneration of the retina that he observed in three children of the same parents. (*Klin. Monatsbl. f. Augenh.* 46: 225, 1908). The ocular symptoms started in the sixth year of life in these patients, terminating in total blindness and dementia. The histologic observations, which varied in each of the three children, were described in detail. A similar condition recently observed by Stock in a man aged 25 is reported and illustrated with

colored pictures. Vision of the right eye failed completely within six months and that of the left within about one month. The patient had an epileptic attack during observation at the ophthalmic clinic. Other epileptic attacks followed; dementia developed, and the patient died a few weeks later. No anamnestic data of importance were found, excepting that one sister had epilepsy. The nervous elements of the retina were completely degenerated. The degeneration occurred so rapidly that the glia had not yet proliferated, and no pigment epithelium had invaded the retina. For the same reason the glia and connective tissue had no time to fill out the vacuoles. The lacunae in the optic nerve resembled those noted in glaucoma and myopia. Stock thinks that the presence of lacunae without the formation of an excavation of the optic nerve supports his opinion that the lacunae cannot be the cause of an excavation.

The form of pigment degeneration here described differs from the known form as follows:

1. It involves the entire retina simultaneously, whereas the known form begins either in the periphery of the retina, progressing toward the macula, or in the equator, progressing toward the periphery and the macula. The absence of dementia points to an isolated disease of the retina in the known form.

2. The onset in the new form is at a more advanced age and may affect a hitherto healthy person.

3. Degeneration of all the ganglion cells of the brain is characteristic; the patient dies from decay of all the organs of the central nervous system. Final high fever can be explained as a result of involvement of the center of regulation of the bodily temperature.

K. L. STOLL.

A POSSIBLE FAMILIAL CONNECTION BETWEEN A CERTAIN BLOOD GROUP AND HEREDITARY PIGMENTARY DEGENERATION OF THE RETINA. R. TERTSCH, *Klin. Monatsbl. f. Augenh.* 97: 585 (Nov.) 1936.

Tertsch attempted to find whether a law exists by which the disposition of a certain hereditary disease may be predicted in a certain person prior to the development of symptoms. After discussing the significance of certain blood groups, and adducing a number of genealogies, the author arrives at the following conclusions from his research:

It is likely that among "direct" brothers and sisters a connection exists between hereditary degeneration of the retina and affiliation to a certain blood group. However, this disease is not connected with a definite blood group, but it may occur in persons of any blood group, as evidenced by data in the genealogies. The afflicted children studied belonged to the same blood group, while the homozygotically healthy children belonged to another blood group than the diseased ones. Furthermore, the phenotypically healthy but heterozygotically diseased children belonged to the same blood group as the homozygotically diseased ones.

The practical value of this research is the solution of the question whether a division is possible between hereditarily healthy persons

and persons with hereditarily suspicious signs for the sake of preventing hereditarily diseased offspring. Examination of other families with hereditary pigmentary degeneration of the retina as to the blood groups to which they belong would further the solution of this problem.

K. L. STOLL.

Trachoma

STUDIES ON THE INFECTIVITY OF TRACHOMA. L. A. JULIANELLE and R. W. HARRISON, *Am. J. Ophth.* 20: 353 (April) 1937.

Julianelle and Harrison give the following summary and conclusions:

"1. The infectious agent of trachoma may be liberated of extraneous bacteria by passage through rabbit testicle.

"2. The infectious agent does not multiply during such passage, but retains its viability and infectivity.

"3. No changes are observable in rabbit testicle during passage which are referable to the agent.

"4. It was not possible to continue passage in series through rabbits.

"5. Survivability in testicular tissue is not related to the presence of detectable elementary or initial bodies.

"6. On other occasions, the infectious agent may be freed of bacteria by intracerebral inoculation of rabbits, in which case the brain tissues show no specific reaction.

"7. The cumulative evidence, therefore, suggests that the infectious agent of trachoma may be a virus."

W. S. REESE.

NEW RESEARCHES ON TRACHOMA. A. CUÉNOD and R. NATAF, *Arch. d'opht.* 53: 355 (May) 1936.

In this report Cuénod and Nataf try to show the nature of the observations in smears and sections which have already been reported on. The question of the rickettsias is discussed, and reference is made to the work of Hertig and Wolbach, Weigl, Rocha-Lima, Anigstein, Busacca, and Thygeson. The experiments detailed first consisted of taking uninfected lice and showing that they can be infected with trachoma material, the virus being found in the intestinal tract, resembling closely what has already been demonstrated in smears and cultures. The second step was the infection of healthy monkeys with ground-up infected lice by subconjunctival injection and by surface inoculation with scarification. The result was the occurrence of typical trachomatous follicles in these animals, with the demonstration in smears of the same organisms as reported for smears from human beings. Further research is in progress. The work so far seems to establish the parasitic nature of the disease and the probability of its origin and of at least one of its modes of transmission through insects harboring rickettsias.

S. B. MARLOW.

Tumors

SYMMETRICAL ORBITAL TUMORS: REPORT OF A CASE. R. VOELKEL, *Klin. Monatsbl. f. Augenh.* 98:169 (Feb.) 1937.

Voelkel reports two cases of symmetrical bilateral tumor of the orbit. The tumors represented systemic diseases of varying clinical appearance. Forty cases of this condition have been reported, but it seems to occur more frequently than this number of reports would indicate. The short time allotted to observation, failure to make excision for histologic examination and lack of a case history may be responsible for the fact that these tumors were considered pseudotumors of unknown origin. Such tumors consist of reticular tissue and of infiltration of lymphoid cells. Resembling genuine tumors, these lymphomas or lymphomatoses are chronic inflammatory hyperplastic lesions which develop on the basis of a general disease of the lymphatic system, such as leukemia, aleukemic lymphadenosis or lymphogranulomatosis.

The first case concerns a man aged 24 with symmetrical exophthalmos and reactive osseous degenerations, osteoporosis and osteosclerosis of the orbit, extending into the ethmoid bone.

An excised piece of tumor contained islands of cells in a tough tissue. The islands consisted of granulation tissue with large histiocyte elements and lymphocytes, eosinophil leukocytes and giant cells resembling Sternberg's giant cells. Numerous foci of hyalinization and sclerosis were observed. Krönlein's operation was performed on the right eye when the exophthalmos increased, revealing a large, tough tumor which covered the posterior portion of the eyeball like a shell. The rearmost portion of the tumor could not be removed from the apex of the orbit. This patient presented symptoms resembling those of Mikulicz' disease.

The second case is that of an emaciated woman aged 42 with proleukemic or leukemic lymphadenosis; most of the lymph glands and also the thyroid gland were enlarged. The lids were protruding and tense; the fornices were swollen, soft and grayish red. This glassy mass separated the eyeball and the lids, which, when everted, remained in that position. An excised portion of the lid showed no amyloid, as was expected, but massive infiltration by round cells with a large dark nucleus, after staining with hematoxylin, and scarcity of protoplasm—leukemic infiltration. Tracheotomy, which was performed because of increasing dyspnea, showed hard infiltrations in the subglottic space; they consisted of lymphoblastic elements containing no Mikulicz cells and only a few eosinophil cells. The patient died two months later from general weakness. The diagnosis was the proleukemic stage of lymphadenosis.

The orbital tumors were the first symptom observed in these two cases, and the diagnosis could be established after examination of an excised piece.

K. L. STOLL.

Uvea

A CASE OF UVEOPAROTITIS. TOULANT and MORARD, *Arch. d'opht.* 53:321 (May) 1936.

Toulant and Morard have collected a total of ninety-seven instances of uveoparotitis from the literature, in five of which the condition

was uncertain. This number includes some cases described as instances of Mikulicz' syndrome, the description of which make them appear to be cases of uveoparotitis. Women were found to be affected in 55 per cent. In two thirds of the patients the disorder occurred between the ages of 10 and 30 years. The disease is not contagious. The majority of the cases have occurred in Anglo-Saxon countries. Clinically the disease is characterized by (1) hypertrophy of the parotids; (2) an ocular manifestation, consisting usually of uveitis; (3) slight fever; (4) facial paralysis and various other pareses, and (5) accessory symptoms, such as multiple glandular invasion, general adenopathy, and visceral and cutaneous lesions. These are all discussed, and the reports in which they have been described are cited. The development of the disease is essentially subacute or chronic, four stages being recognized—a prodromal stage, the onset of which may be hypertrophy of the parotids; iridocyclitis; facial paralysis, and cutaneous lesions and swelling of the lacrimal gland. The fully developed stage is characterized by the coexistence of uveitis and swelling of the parotids. Its duration is never less than fifteen days and is often longer than two months. The period of regression is prolonged. Loss of vision is often the result. The pathologic changes of the disease consist essentially of epithelioid infiltration with the formation of nodular masses. All work to determine the pathogenesis has so far been without results. Theoretical considerations have incriminated mumps, syphilis and tuberculosis, but the evidence is inconclusive. Toulant and Morard are inclined to accept the suggestion of Merrill and Oaks that the disease is due to a special virus as yet unidentified. Treatment is symptomatic. No one form has proved beneficial in all cases. The authors report a new case, which was studied in detail. A complete bibliography is listed.

S. B. MARLOW.

Vitreous

DETACHMENT OF THE VITREOUS: REPORT OF CASES. R. BASSIN, Klin. Monatsbl. f. Augenh. 97: 599 (Nov.) 1936.

There are two types of detachment of the vitreous: the anterior type, in the area of the ora serrata, and the posterior type, near the disk. Only the latter form was known up to 1924. Bassin published a report of two cases of posterior detachment of the vitreous in 1932, and he adds a third case in this report. A man aged 38 with myopia of 23 D. presented a gray, oval opacity in front of the disk. Its margin was 1 mm. wide and open below. Moving only slightly on motion of the eye, it regained its original position at once. While the upper portion could be observed distinctly with a 12 D. concave lens, the lower portion could not be outlined. This seemed to indicate either that the detachment was incomplete or that its lower portion had remained clear. Temporally and below the disk was a diffused, rolled-up gray mass measuring about three-fourths the size of the disk. The choroid around the disk was atrophic; the course of the retinal vessels was not interrupted.

The author reports also a case of anterior detachment of the vitreous in a man aged 70. The detachment was observed after intracapsular extraction of a cataract with iridectomy. The anterior chamber was

deep, and an oblique oval opening was noted behind the iris in the direction from 1 to 7 o'clock, its outline being clearly visible through the coloboma.

The slit lamp revealed a whitish gray membrane with a slightly thickened margin and folds running parallel to it. The membrane lay in the frontal plane, oscillating slightly on extreme motions of the eye.

Bassin thinks that the detachment of the vitreous was caused by pressure on the eye and massage during the difficult delivery of the lens. The detachment was facilitated by the loose connection of the vitreous with the ciliary body and the zonule of Zinn, which, on the other hand, prevented detachment of the retina.

K. L. STOLL.

Therapeutics

THE ROLE OF PARACENTESIS IN OPHTHALMOLOGY. W. F. HARDY, *Am. J. Ophth.* 19: 1097 (Dec.) 1936.

Hardy remarks on the paucity of the literature on paracentesis and the important part this procedure plays in many serious ophthalmic conditions. He discusses the rôle of the aqueous and the question of recovery of an eye when a corneal ulcer perforates, and enumerates the various conditions for which paracentesis is used. The case of a 43 year old man who, after a blow on the eye, suffered from repeated blebs of the cornea, is reported. Numerous forms of treatment were tried; improvement followed paracentesis, and after this procedure was repeated five times the eye made a full recovery.

W. S. REESE.

Toxic Amblyopia

TREATMENT OF TOBACCO AMBLYOPIA BY ACETYL-CHOLINE. B. H. CRAGG, *Bristol Med.-Chir. J.* 53: 237, 1936.

Since July 1936 Cragg has treated five male patients suffering from tobacco amblyopia by the intramuscular injection of acetylcholine bromide. The drug is available in two doses, dose A being 0.03 Gm. and dose B 0.125 Gm. Each patient first received two injections of dose A with an interval of one day between and then a daily injection of dose B until no further treatment was considered necessary or until improvement ceased. In addition, patients 4 and 5 were given 1/150 grain (0.0004 Gm.) of physostigmine sulfate daily by mouth, on the basis of the suggestion that the action of acetylcholine is enhanced by minute doses of this drug. The results were encouraging: It was found that treatment by this method gives more rapid improvement in vision than that by other methods. The patient in most cases realizes that overindulgence in tobacco has been the cause of his defective vision.

J. A. M. A. (W. ZENTMAYER).

Society Transactions

EDITED BY DR. JOHN HERBERT WAITE

GERMAN OPHTHALMOLOGICAL SOCIETY

Fifty-First Annual Meeting, July 6-8, 1936

DOCENT DR. M. BÜCKLERS, Tübingen, *Reporter*

TRANSLATED BY PERCY FRIDENBERG, M.D., New York

Demonstration Session

Tuesday, July 7, 1936

WOLFGANG RIEHM, M.D., Giessen, *Chairman*

IMPROVEMENTS IN PERIMETRY (MAGGIORE'S PROJECTION PERIMETER). DR. PHIL. H. HARTINGER, Jena.

This perimeter, made by Zeiss in Jena, throws images of varying color, size and luminosity on a perimeter arc which is about 8 cm. wide and has a radius of curvature of 333 mm. The inner surface of the arc, which is presented to the eye of the subject, is enameled a dull gray with a white content of about 35 per cent. The test field extends from a central cruciform test object 100 degrees to right and left. The test objects are 10, 5, 3 and 1 mm. in size, corresponding to visual angles of 1.7, 0.9, 0.5 and 0.2 degrees, respectively. The colors, red, yellow, green and blue, correspond almost to those of the so-called Heidelberg perimeter. The luminosity can be reduced quickly and accurately by three smoked glasses with a permeability to light of $\frac{1}{4}$, $\frac{1}{16}$ and $\frac{1}{64}$. By means of a hand wheel, the test object can be moved noiselessly from one extremity of the arc to the other and stopped at any desired point. There is also a "blinking" arrangement by means of which the test image can be instantaneously extinguished or made to reappear. The diagram for the notation of the visual field is fastened in a frame and remains stationary while the arc and the light projector are rotated. The wires for the latter, running over the diagram, accordingly indicate unmistakably the axis of the meridian which is under examination at any given moment. A pencil carried along in the course of the wires allows the accurate designation of the location of the test image. The field diagram corresponds to the accurate "equidistant polar projection" of Förster, adopted at the International Ophthalmological Congress at Madrid in 1933. The scale division of the semicircular arc corresponds to the Oca diagram, and the notation is supposed to take place as if the observer were looking at the drawing of the outline of the visual field from the convex side of the perimeter arc. This field diagram is illuminated uniformly and equally by the only light source of the apparatus, without the subject under examination being in any way aware of this illumination. Great care has been taken in the

construction of this apparatus to ensure the correct and unchanging position of the subject's eye. The chin rest and brow support can be raised and/or lowered and also rotated about a vertical axis and shifted to one or the other side, so that either eye can be brought rapidly to center on the perimeter arc. The inclination of the head rest can be regulated and, with it, the distance of the tested eye from the perimeter arc. In addition, three different chin rests are provided. To exclude the eye which is not under observation, two tongue-shaped "blindners" are attached to the head rest and can be rotated and lowered with it. Finally, an important innovation is presented—a provision for the optical centering of the eye under examination. Image projectors are placed in two tubes which run obliquely downward from the lamp holder. From two spatially separated points two luminous rings are projected on the subject's eye. When these rings coincide and are concentric to the pupil, the eye is exactly at the center of the perimeter arc. The observer is able to center the subject's eye, to map the visual field and to watch the field diagram and the patient from one and the same place. The luminosity of the test object images remains unaltered during the determination of the limits of the visual field, and the color and luminosity can be repeated accurately when and as desired. Accordingly, the data of measurements at different times or places can be compared without question. The color, luminosity and size of the test object image can be varied quickly without attracting the attention of the patient. Finally, this change in position of the optically produced test objects takes place silently, so that the subject gets no hint which might influence or falsify his statements in an undesirable way.

PRESENT FORM OF APPARATUS FOR MEASURING THE POSITION OF THE VISUAL AXIS IN NEAR VISION. DR. LUDWIG PAUL, Lüneburg.

This instrument is a mechanical improvement on the model described in the *Klinische Monatsblätter für Augenheilkunde* (93:528, 1934). The reading test cards, formerly movable, are now fastened. The data gained correspond perfectly with those obtained with the old apparatus, but examination is greatly facilitated in that the subject has now only to indicate on the reading disk the place where the red marker seems to lie. It is seen only by the fixing eye, having been projected into the visual field of this eye by the exclusion of binocular vision. All measurements of inclination (*Rollung*), fusion movements, etc., can be carried out just as with the older model. The subject easily understands the simple order to point out the red marker which he perceives, so that the examination, which may be of essential significance in the diagnosis and treatment in a given case, can generally be carried out in a few seconds. The apparatus is made by Wurach in Berlin.

A NEW MEASURE OF INTERPUPILLARY DISTANCE. DR. H. HARMS, Berlin.

The instrument which can be used to measure the distance between the centers of rotation (by the subjective method) also measures the interpupillary distance objectively. It consists of two parallel tubes

which can be reciprocally displaced. Each tube contains an iris diaphragm (*Schluessellochblende*) with a needle placed behind the central opening. The central opening and the needle must coincide when the center of rotation of the eye is in the axis of the tube. If both tubes are correctly centered, according to directions, their distance apart will correspond to that of the centers of rotation of the two eyes. The possibility of an obliquity of the so-called basal line can also be taken into consideration. The examining physician can sight the upper part of the subject's nose and read the distance from the right point of rotation. If the entire instrument is turned around and the diaphragm pushed out of the tubes, the points of the needles can be brought opposite the middle of the subject's pupils and their distance from one another measured.

A METHOD FOR CONTINUOUS REGISTRATION OF DARK ADAPTATION.
 PROF. WERNER KYRIELEIS, Hamburg.

A mechanism is described by means of which the width of the diaphragm (*Blendenweite*) of the Engelking-Hartung adaptometer is continuously registered on the drum of a slowly running kymograph. In this way up to ten determinations of threshold values per minute can be carried out. In addition, the finer details of the course of the curve for dark adaptation are presented much better than with the older methods previously in use. The mechanism seems invaluable and essential for the study of after-images resulting from dazzling and similar reactions.

SIMPLE ATTACHMENT TO THE COMBERG OPHTHALMOSCOPE (MODEL I)
 FOR FOCAL EXAMINATION OF THE FUNDUS. PROF. ALOIS MEES-
 MANN, Kiel.

This attachment consists of an iris diaphragm the aperture of which can be regulated by a ring at the periphery. This is mounted in a cylindric case which can be shifted up or down, so that with refraction errors up to myopia of 12 D. it is possible to focus sharply on the background of the eye. The upper half of the original illuminating tube is unscrewed and replaced by one which contains the attachment just described. The instrument can be used for examination in the upright or in the reversed position, and its use at the operating table or at the bedside is very simple.

DEPOSITS OF CHOLESTEROL CRYSTALS ON THE POSTERIOR SURFACE OF
 THE CORNEA AND THE ANTERIOR SURFACE OF THE LENS IN AN
 OTHERWISE SOUND EYE. PROF. ALOIS MEESMANN, Kiel.

Examination of a patient aged 66 with pernicious anemia of a mild degree showed no arcus lipoides and no rise in the cholesterol content of the blood. The possibility of a relation of toxic steatosis to pernicious anemia is considered, as is that of a variation in the chemical composition of the aqueous humor, with resulting sedimentation of crystals. Further investigation might determine whether such changes are fre-

quent in cases of pernicious anemia. As they do not interfere with vision, it is possible that they are often present but are overlooked and so have remained unknown.

THE ANGULATED MICROSCOPE FOR EXAMINATION OF THE VITREOUS AND FUNDUS IN THE SLIT LAMP BEAM. PROF. KARL LINDNER, Vienna.

The microscope is mounted on the stand of the ordinary slit lamp. Sighting takes place directly across and through the instrument. In addition, the slit must be narrowed to the smallest possible dimensions. A contact glass with a small surface is used. The one I use has a diameter of 15 mm. A contact glass is being prepared with a flat surface curvature which will permit of the examination of the fundus oculi as well. With this helpful accessory, one can examine the vitreous and the fundus in serial sections, so to speak, with the slit lamp beam. Particularly excellent pictures are obtained by examination with red-free light, which, however, requires a special arc lamp (direct current) for a light source.

THE COLLOIDOMETER, A SLIT LAMP ATTACHMENT FOR THE DETERMINATION OF CHANGES IN LUMINOSITY IN PATH OF LIGHT IN THE ANTERIOR CHAMBER. PROF. HENNING RÖNNE, Copenhagen, Denmark.

In passing through the cornea, the beam of the slit lamp produces a path of light the luminosity of which is essentially greater in the cornea than in the aqueous with its more or less considerable albumin content. The colloidometer makes use of a Recoss disk with twelve graduated gray (smoked) glasses to dim the slit lamp beam partially until there is equality between the path of light through the undimmed anterior chamber and that through the dimmed cornea. In this way one can determine the varying path of light in the anterior chamber as compared with the constant path in the cornea. As each of the twelve gray glasses has a different and definite potential of light transmission, the dimming value of the neutralizing or equalizing glass will give the albumin content of the aqueous. At the same time this allows one to follow the course of iritis from the beginning to the end, quantitatively and graphically (*kurvenmässig*). Variations in the luminosity of the path of light in the anterior chamber are more than a thousandfold. The instrument is made by Carl Zeiss in Jena.

DEMONSTRATION OF A CYCLOPHOROMETER. DR. H. HARMS, Berlin.

This cyclophorometer is a stereoscopic apparatus with two rotating arms. The separation of their centers of rotation is made equal to that of the ocular centers of rotation. Each arm carries an object disk with a centrally placed circle of apparently equal dimensions. One of the disks is small and square (*quadratisch*) and is made of paper ruled in millimeter squares. It is placed in front of the eye at a distance of 6.7 mm. The other disk is large and round, can be rotated and bears a red streak which runs through the middle point. This disk is

33.3 cm. distant from the eye. By the placing of a + 15 D. sph. and a + 3 D. sph., respectively, in front of the eyes, the disks are transported into the far point of vision of an emmetropic eye. The red line now appears to one looking into the apparatus to lie in the plane of the chart paper and is made to fix parallel to the vertical rulings. Its inclination to the vertical corresponds to the reciprocal inclination of corresponding retinal meridians. Allowance must be made, of course, for errors of refraction in putting on the plus lenses. Any desired accommodation can be elicited by using weaker lenses, and any desired convergence can be enforced by rotating the arms of the stereoscope inward. This apparatus has various practical applications.

AN APPARATUS FOR TRAINING CENTRAL VISION IN FUNCTIONAL AMBLYOPIA. PROF. W. COMBERG, Rostock.

This apparatus is intended to exercise the macular region of an eye with eccentric fixation. With the aid of this fixation, the eye is placed in such a position, the head being supported on a chin rest, that the macular region is directly opposite a test object. When a button is pressed, the red light of the eccentric fixation point disappears and a very bright image is flashed for a moment onto the macular region. The training exercises are held in a dark room so as to keep the eye free from all extraneous stimuli. The test objects are arranged on a rotating disk which the subject turns, constantly bringing new test objects into position for this procedure in a succession of which he has no inkling. There are changeable rings with test objects of different sizes corresponding to vision of $\frac{1}{30}$, $\frac{1}{10}$ and so on.

SIMPLIFIED COMBERG X-RAY APPARATUS FOR THE LOCALIZATION OF FOREIGN BODIES. DOCENT DR. MAX BÜCKLERS, Tübingen.

In order to minimize errors in taking roentgenograms, I have had an instrument constructed in which all requirements of accuracy are ensured by simple manipulations. For this purpose, the Siemens roentgen sphere is mounted 60 cm. above the exposure table in such a way that it can be moved in only two directions above the plate, which is held fast in a frame. A millimeter scale attached to the directing rod and to the detachable sighting mirror is used to correct centering, so that the central light ray shall be invariably vertical to the middle of the plate and to the middle of the mirror, respectively. For fixation there is an accessory light source which fits into the bayonet lock of the x-ray tube holder in such a way that the miniature lamp lies exactly in the direction of the central light ray.

INJURIES TO THE EYE FROM COMPRESSED AIR WITHOUT EXTERNALLY VISIBLE LESIONS: DEMONSTRATION. DR. LABIL REINHARD BRAUN, Rostock.

The eyes of two patients were subjected to blunt injury by being struck by hose or hose terminals under high pneumatic pressure. In the first case there was a central scotoma, the presence of which was verified by differential pupillometric tests, without any visible changes in the optic disk. In the second case there was papilledema without any dis-

turbance of function. The striking feature in both cases was the complete absence of even the slightest external lesion. It is inferred that the sudden and sharply jolting traumatism had resulted in only slight injury to the optic nerve alone, such as hemorrhage into the nerve sheaths or commotio nervi optici.

UNUSUAL SEQUELAE OF INJURY BY CONCENTRATED TEAR GAS. DR.
ROLF SCHMIDT, Freiburg.

Toward the end of November 1935, a patient aged 40 was brought to the hospital two hours after a cartridge containing concentrated tear gas (bromomethylethyl ketone) was shot into his right eye at short range. On admission there was marked swelling of the right side of the face with striate cauterizing of the skin. The lids of the right eye were tensely swollen and bloodshot, and the globe was torn to shreds. The globe was enucleated immediately, evipan (the sodium salt of C-C-cyclohexenyl-N-methyl-barbituric acid) being used for anesthetization. The tissues gave off a highly irritating gas which caused such intense lacrimation that it was almost impossible to complete the operation. In the following days there occurred, quite unexpectedly, a further increase in the swelling of the lids, with marked protrusion of the conjunctival sac. At the same time there developed, together with marked sanious secretion, a progressive necrosis of the remaining orbital tissues and of the lids, which began to slough in shreds. For this reason, twenty days after injury exenteration of the orbit was performed, in the course of which several small splinters of glass were found near the apex of the orbit. Here, again, the gas issuing from the tissues was highly annoying. Even after this procedure the disease process did not come to a standstill. The periosteum of the orbit commenced to slough at different points. The necrosis even extended to the skin of the face and the facial skeleton. The zygomatic process of the frontal bone began to break down, not from within, i. e., the orbital aspect, but from the outside. And now, for the first time, extremely slowly progressive granulation of the extensive wound surface began to take place from the nasal wall of the orbit. By the end of May, half a year after the original injury, the necrosis finally ceased. The remarkable feature in this case is that tear gas, which is generally considered to be harmless and to cause only transient irritation, may cause high grade destruction and permanent damage when it is carried deep into the tissues in a concentrated form. In the case recently reported by Heinsius from the Berlin clinic, severe areas of burn were also present, but the necrosis was limited to the surface and there was none of the progressive severe and spreading destruction of deeper tissues which was observed in the case reported here. Careless handling of tear gas, which is now used rather frequently, may at any time cause a repetition of such injuries.

THE APPEARANCE OF SO-CALLED PIT FORMATION (GRUBENBILDUNG)
IN THE PAPILLA NERVI OPTICI OBSERVED WITH THE ANGULATED
MICROSCOPE OF LINDNER. H. RIEGER, Vienna.

From colored pictures depicting the so-called pit formation in the papilla nervi optici as seen with the Lindner microscope, it was found beyond dispute that there was a fine cuticulum which spread over the

pit. While two cases do not prove that pit formation invariably represents a cystic cavity in the substance of the nerve head, at least they speak in favor of the histologic interpretation advanced by von Szily in 1913 and again in 1920 to the effect that this malformation is due to defects or actual lacunae in the so-called intercalary portion (*Schaltstueck*).

CONGENITAL ANIRIDIA. DR. W. REICHLING, Berlin.

The eyes of a boy aged 12 weeks were examined histologically. Before death the ocular findings were moderate nystagmus and complete amaurosis. Nothing was to be seen of the iris in either eye, the fundus was strikingly devoid of pigment and the disk showed no gross changes. On account of the restlessness of the child it was not possible to make a satisfactory inspection of the macular region. Of the relatives who were examined, the father, mother and a sister aged 1½ years, only the first named showed any ocular developmental anomaly, viz., an oval pit formation in the nerve head. Histologic examination of both eyes of the patient showed a bilateral anterior polar cataract with considerable iris rudiment. The stroma iridis in each eye was rich in nuclei; the length and breadth of the irides vary markedly, especially in sections which were widely separated. There was ectropium of the uvea on each side. Contrary to what is frequently reported in the literature, both the dilator and the sphincter muscle could be demonstrated in numerous sections. In the filtration angle of the anterior chamber the uveal framework (*Gerüstwerk*) was replaced by a knot of stroma iridis. Where the uveal framework was still present and strands could be followed up, they could be seen in various sections to run on the posterior surface of the cornea and to end in a sort of bolster made up of coarsely fibrous tissue. The most striking histologic change in the retina was the absence of the central area and of rods and cones in many places. A remnant of the hyaloid artery was noted, resting directly on the disk.

CONTRIBUTION TO OCULAR PATHOLOGIC PROCESSES IN IDENTICAL TWINS: PRESENTATION OF TWO DRAWINGS OF THE FUNDUS AND A PHOTOGRAPH OF THE TWINS. DOCENT DR. KURD VOGELANG, Berlin.

The twins, Gerhard and Arno, were aged 8 years. The right eye of Gerhard showed a sharply defined coloboma of the macula with a profusion of pigment. The right eye of Arno showed a pigmented macular coloboma with a sharp margin and grayish white prolongations to the temporal side. The report from the department for hereditary pathology of the I. Medizinische Klinik der Charité (Prof. Dr. Curtius) stated that undoubtedly identical and hereditarily equivalent (*erbgleich*) twins presented characteristics which were in part asymmetrically mirrored (*spiegelbildlich asymmetrisch*). The father, aged 38, presented a slight irregularity of the pupils, which were not perfectly round. There was a marked physiologic excavation of the disk in each eye, which was more marked in the right. The macula was intact. The mother, aged 38, had had trouble with the right eye for nine-

teen years. The fundus showed tortuosity of the retinal vessels and a deep excavation extending to the margin of the disk. The tension in the right eye was 67 mm. of mercury, and there was perception of light. Examination of the left eye showed a flat papilla, venous pulsation and tension of 38 mm. The diagnosis was juvenile glaucoma (?). The Wassermann reaction was negative in all four subjects. There was almost complete correspondence of the configuration of the colobomas. In considering the significance of this clinical finding from the standpoint of genetics and certification, heredopathologically there were certain relations to the problem of symmetry and to that of coloboma formation in correlation with other developmental anomalies.

PRIMARY GLIOMA OF THE ORBIT. PROF. W. ROHRSCHEIDER, Cologne.

A 3½ year old boy presented a rapidly growing orbital tumor which was pushing the globe downward and forward. The eyeball presented no pathologic change, and there was no papilledema. Exenteration of the orbit was done. Relapse occurred with metastasis in the lymph glands at the angle of the jaw. The growth was remarkably soft, almost disintegrating, and semifluid (*zerfliessend*). Histologically, the growth was rich in cells of various size; they were mostly round, but some were spindle shaped, and here and there a thick conglomeration of neuroglia fibers could be seen, as proved by Holzer's glia stain. A diagnosis of glioma sarcomatodes was made. The optic nerve was not pathologically altered. The tumor formation was ascribed to embryonic germinal displacement. I wish to call attention to the rarity of primary glioma of the orbit and to the possibility of mistaking the tumor in question for a myxosarcoma.

A PECULIAR FORM OF RETINAL PIGMENTATION: DAPPLED (GESCHECKTER) FUNDUS. PROF. KARL VOM HOFE, Greifswald.

A student of medicine aged 24 presented a peculiar form of retinal pigmentation. The anterior segment of the retina was normal; the media were clear. On the fundus there was a wide area of peripapillary bleaching or of partial depigmentation (*Aufhellung*) around the disk. The greater portion of the fundus, with the exception of the macular region and that around the disk, showed a massive accumulation of pigment, mostly in clumps (*Schollen*), over which the retinal vessels coursed unobstructed. There was only a little scattered pigment, mostly punctate, here and there in the anterior layers of the retina. Between the pigmented areas there were unpigmented areas which reminded one of coloboma and in which no choroidal vessels or only an occasional solitary branch was seen. Vision in each eye was — 5/4. Accommodation was normal and the visual fields for white and blue were also normal. A test for color vision showed deuteranomaly. The course of the curve and the final values for dark adaptation were normal, with a definite sharp notch (*Knick*) in the curve after five minutes. According to the family history an aunt had become blind in her forties from some cause, and the daughter of a cousin who had married a (female) cousin was said to be an albino. A sister of the patient presented a normal fundus. The other anamnestic data could not be verified objectively. In view of

the function, which was normal in every respect, the complete absence of objective symptoms and the family history, it is fair to conclude that the condition being dealt with was a congenital anomaly with a hereditary basis, which is best designated as dappling of the fundus (*Scheckung*). There is no question of the condition's being "grouped pigmentation" (Niels Höeg and others), as the pigment was irregularly scattered, not grouped. But it is probably related in some way to this pigment anomaly as well as to others, such as those described by Jacobi, Kraupa and others.

A RARE FORM OF ASSOCIATED MOVEMENT OF THE EYE: PRESENTATION OF A FILM. PROF. HUGO GASTEIGER, Frankfurt on the Main.

A man of 41 was injured by a grenade, the region in front of the right ear being involved. Later, a number of splinters from the projectile were removed by operation. In addition to some neurologic symptoms, the following conditions of the right eye were noted: The fissure in the lid was narrowed, and there was a slight degree of enophthalmos. Abduction was completely absent, but all the other ocular movements were full and free. Chewing movements, depending on their vigor, were associated with weak to violent nystagmus-like movements of the right eyeball in a horizontal direction. These movements were accompanied by a pulsating movement in the region of the radiating cicatrix in front of the right ear. When the chewing motion was finished, the twitching of the eyeball and the pulsation in the region of the scar ceased abruptly. The globe was normal except for a corneal opacity and a delicate cataracta punctata coerulea. The left eye was normal. The cause of the associated movements of the right eye was found to be the cicatricial adhesions between the abducting muscle and the muscles of mastication in the region opened up by the shot. This was proved by the simultaneous movement of the scar and by the roentgenogram which showed the osseous defect and foreign bodies in the right orbit.

CONTRIBUTION TO THE BIOLOGY OF SARCOMA OF THE CHOROID: PRESENTATION OF A SERIES OF COLORED PHOTOGRAPHS OF MICROSCOPIC SECTIONS. PROF. E. SEIDEL, Jena.

A woman aged 29 had a condition which was diagnosed elsewhere as a cyst of the ciliary body on the ground of positive scleral transillumination, and an attempt was made to extirpate the supposed cyst. Six months later the globe was enucleated. Histologic examination showed a flat, almost unpigmented sarcoma of the ciliary body, 2 mm. thick and reaching to the equator. In the region of the operative scar and along the canals made around the suture material (female hair) by the needle punctures, tumor cells had proliferated into the sclera. I wish to call attention to the danger of puncturing or of otherwise operatively opening a globe in a case of sarcoma of the uveal tract.

OCULAR METASTASIS OF A CHORIONEPITHELIOMA DR. W. REICHLING, Berlin.

The eye of a man aged 36 had been enucleated because a choroidal sarcoma was thought to be present. The further clinical course and a

general physical examination demonstrated that the growth was an ocular metastasis from a tumor of the right testicle. Death from multiple metastases took place two months later. Histologic examination of the enucleated eye showed almost complete correspondence of the two neoplastic formations. At many points the cell forms characteristic of malignant chorionepithelioma were found, viz., the syncytial cells, large epithelial cells derived from the outermost fetal layer of the placenta, and the smaller Langerhans cells, derived from the epithelium of the chorionic villi. There were a marked tendency to hemorrhagic effusion at many points and also a severe reactive hyperemia in all the blood vessels of the intra-ocular structures.

(To Be Continued)

Book Reviews

Report of the Ukrainian Institute for Experimental Ophthalmology, 1936, Odessa. By Prof. W. P. Filatoff. Pp. 50. U. S. S. R. Commission of Public Health, 1937.

The Ukrainian Institute for Experimental Ophthalmology is to continue the work begun by Professor Filatoff in the Institute of Medicine in Odessa. The new institute is to contain a clinic service of 100 beds, 6 laboratories and an experimental studio. The institute has been open since Sept. 1, 1936, and this report tells of the work during four months.

One hundred and fifteen patients have been treated in the institute and the following 112 operations have been done: 62 transplantations of the cornea, 27 operations for glaucoma and 23 other operations.

The problems which have been studied during this period have concerned the transplantation of the cornea. Professor Filatoff has been transplanting corneas for many years and has always used eyes obtained from living patients, but the large demand and the insufficient supply of material for transplantation have led him to take eyes from cadavers. Since 1931 he has used these eyes, conserved by cold. The subsequent operations have shown that grafts from this material give just as good, if not better, results than grafts from eyes of living patients. The eyes are preserved at a temperature of from 2 to 4 F. Sixty-two transplantations were made in four months. In only 2 of these was material taken from eyes of living patients.

On January 1 the sum total of the transplants which had been made at Odessa was 380. At present the number has reached 400, and in the case of 200 of these the material was from cadavers. The results were as follows: A transparent graft was obtained in 32 of 44 cases (72.7 per cent); in 8 the graft was semitransparent, and in 4 it was opaque.

The word transparent means the ability to recognize details in the anterior chamber and to obtain a clear reflex from the eyeground.

The period of observation has been increased by four months, and in only 2 cases has a transparent graft become semitransparent.

Photographs illustrating 30 cases of transparent graft and 6 cases of semitransparent graft are given. There are also 9 photographs of eyes which were operated on in the ophthalmologic clinic during 1936, and a detailed description of these cases is given.

The work in the laboratory has consisted in a study of better methods of conserving the cadaveric cornea, the biologic study of the preserved cadaveric cornea and the investigation of the best operative procedure for transplantation. This has shown that the cornea preserved in cold and the dried cornea will remain viable.

The second principal problem has been the elaboration of operations for secondary glaucoma. A series of new trephines for the transplantation of the cornea have been invented by Professor Filatoff and Marzinkowsky.

Nineteen physicians have been studying at the institute, devoting their time to transplantation of corneal grafts and the transplantation operation.

In 1937 the new laboratory and 50 beds will have been available. This will permit the investigators to do more experimental work and obtain better success, with the object of assuring the health of the workers of the country, which is governed by socialism under the direction of Comrade Stalin.

In 1937 the following problems were to be studied:

1. Simplification of the operation of corneal grafting so that it can be performed by all physicians.
2. Treatment of keratitis by transplantation.
3. Treatment of lupus and other cutaneous diseases by transplantation.
4. Further study of transplantation of the cornea from the cadaver.
5. The study of corneal graft as a curative factor.
6. The study of biologic processes in the preserved cornea.
7. The cause of glaucoma.
8. The treatment of secondary glaucoma.
9. The cause and treatment of trachoma.
10. The treatment of pigmentary retinitis and tabetic atrophy of the optic nerve.
11. The treatment of complications of malignant myopia.
12. The production of instruments for corneal grafting.

ARNOLD KNAPP.

La migraine ophthalmique. By G. Renard and A. Pascal Mekdjian. Price, 22 francs. Pp. 146. Paris, Masson & Cie, 1937.

After an introduction and description of the clinical symptoms of ophthalmic migraine, the authors, Renard, professor of medicine, and Mekdjian, assistant in ophthalmology, define the problems which are presented by the visual and the sensory expression of migraine and their localization.

In the second part of the book the special field in which these symptoms occur is examined, and their modification with the patient's age and their morbid associations are discussed. The varieties of scotoma are well illustrated. According to the authors, those suffering from migraine show: (1) digestive disturbances; (2) neurovegetative disturbances; (3) humoral disturbances; (4) oscillations of the arterial tension, with a preponderance of hypotension; (5) psychic disturbances, and (6) endocrine disorders.

One may conclude that the migrainous constitution depends on these secondary states of the neurohumoral-endocrine equilibrium, which are generally unstable and may be acquired or be transmitted by heredity.

There are two groups of disorders which seem to have points of contact with ophthalmic migraine: One develops in the form of crises, the clinical aspects of which resemble those of a migrainous crisis; in this group belongs particularly the usual type of migraine and of epilepsy. The second group includes varying disorders which seem to be produced

in persons of the same constitution as those with ophthalmic migraine, alternating with or accompanying this condition, as gout, obesity, diabetes and other conditions.

There is no uniform treatment for migraine. When a patient with ophthalmic migraine comes for treatment it is necessary to examine the eyes, digestive function, endocrine organs and arterial tension. In addition to treating these symptoms, it is necessary to change the patient's make-up. For this hygiene is necessary—the avoidance of fatigue, excesses and a sedentary life, and other measures. It is well to remember that strong remedies should not be used. The authors employ for patients with frequent crises phenobarbital in repeated doses of from 1 to 2 grains (0.06 to 0.1 Gm.) in the evening. Then, for periods of from eight to sixteen days, before the midday meal, from 5 to 10 drops of tincture of belladonna is given. Most patients improve with this treatment. In addition, in cases in which crises are not frequent the authors try only to correct the functional disturbance. Unfortunately, they have no means of suppressing the attacks of migraine. Perhaps further knowledge of the pathology and etiology will give the hoped-for result.

ARNOLD KNAPP.

Outline of Ocular Refraction. By J. T. Maxwell, M.D. Price, \$7.50. Pp. 395, with 135 illustrations. Omaha: Medical Publishing Company, 1937.

This is an exceptionally interesting and valuable book, written by one who has evidently had considerable experience in all the practical details of prescribing glasses, from the initial refraction done in the office to the grinding of the lenses and the fitting of frames.

The chapter on applied optics deals chiefly with the theory of glasses and contains many tables which are of value and are not often found in less practical books, such as the table giving the values of decentration of cylinders at different axes and that giving the effective powers of different types of lenses.

The most stimulating chapter is that on ocular physiology, which is chiefly concerned with the relation of the muscle balance to the static and dynamic refraction. The main thesis of this is that the tonic innervation of the ocular muscles, determined by dissociation tests such as the Maddox rod, is not the final indication for the prescribing of prisms or orthoptic exercises but that the fusional innervation is the factor which should eventually decide what treatment is to be followed. This ties with much of the recent work which has been done on orthoptics, and establishes this form of treatment on a more rational basis. Some may not agree with the reasoning expressed, or with the conclusions drawn in every case, but they cannot help but find the ideas original and stimulating.

The chapters on ophthalmoscopy and perimetry are not as good, but they are more than made up for by the chapter on the trial case and accessories and that on aids to greatly reduced vision. At the end of the book is an excellent appendix on ophthalmic lenses.

The book is concise and well written and will be read with enjoyment by experienced ophthalmologists as well as graduate students.

FRANCIS HEED ADLER.

Directory of Ophthalmologic Societies *

INTERNATIONAL

INTERNATIONAL ASSOCIATION FOR PREVENTION OF BLINDNESS

Honorary President: Prof. F. de Lapersonne, 217 Fauborg St. Honoré, Paris.

President: Dr. P. Bailliant, 66 Boulevard Saint-Michel, Paris, 6^e.

Secretary-General: Prof. M. Van Duyse, Université de Gand, Gand, Prov. Ostflandern, Belgium.

All correspondence should be addressed to the President, Dr. P. Bailliant.

INTERNATIONAL OPHTHALMOLOGIC CONGRESS

Secretary: Dr. E. Marx, Costzeedijk 316, Rotterdam, Netherlands.

INTERNATIONAL ORGANIZATION AGAINST TRACHOMA

President: Dr. A. F. MacCallan, 33 Welbeck St., London, W., England.

FOREIGN

BRITISH MEDICAL ASSOCIATION, SECTION ON OPHTHALMOLOGY

President: Dr. P. E. H. Adams, 6 Holywell, Oxford.

Secretary: Dr. Thomasina Belt, 13 Mitchell Ave., Jesmond, Newcastle-on-Tyne.

CHINESE OPHTHALMOLOGICAL SOCIETY OF PEIPING

President: Dr. H. T. Pi, Peiping Union Medical College, Peiping.

Secretary: Dr. C. K. Lin, 180 Hsi-Lo-yen, Chienmeng, Peiping.

Place: Peiping Union Medical College, Peiping. Time: Last Friday of each month.

GERMAN OPHTHALMOLOGICAL SOCIETY

President: Prof. Lohlein, Jena.

Secretary: Prof. A. Wagenmann, Heidelberg.

MIDLAND OPHTHALMOLOGICAL SOCIETY

President: Dr. T. E. Ashdown Carr, 34 Charnwood St., Derby, England.

Secretary: T. Harrison Butler, 81 Edmund St., Birmingham, England.

Place: Birmingham and Midland Eye Hospital.

OPHTHALMOLOGICAL SOCIETY OF EGYPT

President: Prof. Dr. Sayed Abdel Hamid Soliman Pasha, Faculty of Medicine, Cairo.

Secretary: Dr. Abdel Fattah El Tobgy, 3 Midan Soliman Pasha, Cairo.

Time: March 1938.

OPHTHALMOLOGICAL SOCIETY OF THE UNITED KINGDOM

President: Mr. Gordon M. Holmes, 9 Wimpole St., London, W. 1.

Secretary: Mr. J. D. M. Cardell, 27 Weymouth St., London, W. 1.

OPHTHALMOLOGY SOCIETY OF BOMBAY

President: Dr. D. D. Sathaye, 127 Girgaum Road, Bombay 4.

Secretary: Dr. H. D. Dastur, Dadar, Bombay 14.

Place: H. B. A. Free Ophthalmic Hospital, Parel, Bombay 12. Time: First Friday of every month.

* Secretaries of societies are requested to furnish the information necessary to make this list complete and to keep it up to date.

OXFORD OPHTHALMOLOGICAL CONGRESS

Master: Dr. C. G. Russ Wood, Hill House, Abberbury Rd., Iffley, Oxford, England.

Hon. Secretary-Treasurer: Dr. F. A. Anderson, 12 St. John's Hill, Shrewsbury, England.

Time: July 7-9, 1938.

PALESTINE OPHTHALMOLOGICAL SOCIETY

President: Dr. Arieh Feigenbaum, Abyssinian Str. 15, Jerusalem.

Secretary: Dr. E. Sinai, Tel-Aviv.

POLISH OPHTHALMOLOGICAL SOCIETY

President: Dr. W. Kapuściński, 2 Waly Batorego, Poznań.

Secretary: Dr. J. Sobański, Lindley'a 4, Warsaw.

Place: Lindley'a 4, Warsaw.

ROYAL SOCIETY OF MEDICINE, SECTION OF OPHTHALMOLOGY

President: Dr. Ransom Pickard, 31 E. Southernhay, Exeter, England.

Secretary: Dr. A. Rugg-Gunn, 35 Harley St., London, W. 1.

SOCIÉTÉ FRANÇAISE D'OPHTHALMOLOGIE

Secretary: Dr. René Onfray, 6 avenue de la Motte Picquet, Paris, 7è.

SOCIETY OF SWEDISH OPHTHALMOLOGISTS

President: Prof. K. G. Ploman, Stockholm, Sweden.

Secretary: Dr. K. O. Granström, Södermalmstorg 4 III tr., Stockholm, Sö., Sweden.

TEL-AVIV OPHTHALMOLOGICAL SOCIETY

President: Dr. D. Arieh-Friedman, 96 Allenby Str., Tel-Aviv.

Secretary: Dr. Sadger Max, 9 Bialik Str., Tel-Aviv.

TSINAN OPHTHALMOLOGICAL SOCIETY

Chairman: Dr. Eugene Chan, Cheeloo University School of Medicine, Tsinan, Shantung.

Place: Cheeloo University School of Medicine. Time: Last Thursday of alternate months.

NATIONAL

AMERICAN MEDICAL ASSOCIATION, SCIENTIFIC ASSEMBLY, SECTION ON OPHTHALMOLOGY

Chairman: Dr. Parker Heath, 1553 Woodward Ave., Detroit.

Secretary: Dr. Derrick T. Vail Jr., 441 Vine St., Cincinnati.

Place: San Francisco. Time: June 13-17, 1938.

AMERICAN ACADEMY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY, SECTION ON OPHTHALMOLOGY

President: Dr. Harry S. Gradle, 58 E. Washington St., Chicago.

Executive Secretary-Treasurer: Dr. William P. Wherry, 1500 Medical Arts Bldg., Omaha.

AMERICAN OPHTHALMOLOGICAL SOCIETY

President: Dr. Frederick H. Verhoeff, 243 Charles St., Boston.

Secretary-Treasurer: Dr. Eugene M. Blake, 303 Whitney Ave., New Haven, Conn.

Place: San Francisco. Time: June 9-11, 1938.

CANADIAN OPHTHALMOLOGICAL SOCIETY

President: Dr. W. Gordon M. Byers, 1458 Mountain St., Montreal.

Secretary-Treasurer: Dr. Alexander E. MacDonald, 421 Medical Arts Bldg., Toronto.

NATIONAL SOCIETY FOR THE PREVENTION OF BLINDNESS

President: Mr. William Fellowes Morgan, 50 W. 50th St., New York.
Secretary: Miss Regina E. Schneider, 50 W. 50th St., New York.

SECTIONAL

CENTRAL WISCONSIN SOCIETY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

President: Dr. L. C. Gardner, 11 N. Main St., Fond du Lac.
Secretary: Dr. G. L. McCormick, 626 S. Central Ave., Marshfield.
Place: Marshfield. Time: May 1938.

NEW ENGLAND OPHTHALMOLOGICAL SOCIETY

President: Dr. Edwin B. Goodall, 101 Bay State Rd., Boston.
Secretary-Treasurer: Dr. William P. Beetham, 5 Bay State Rd., Boston.
Place: Massachusetts Eye and Ear Infirmary, 243 Charles St., Boston. Time:
8 p. m., third Tuesday of each month from November to April, inclusive.

PACIFIC COAST OTO-OPHTHALMOLOGICAL SOCIETY

President: Dr. William D. Donohue, 1930 Wilshire Blvd., Los Angeles.
Secretary-Treasurer: Dr. C. Allen Dickey, 450 Sutter St., San Francisco.
Place: Victoria, B. C. Time: June 21-24, 1938.

PUGET SOUND ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. A. W. Howe, 740 St. Helens Ave., Tacoma, Wash.
Secretary-Treasurer: Dr. Purman Dorman, 1115 Terry Ave., Seattle.
Place: Seattle or Tacoma, Wash. Time: Third Tuesday of each month, except
June, July and August.

ROCK RIVER VALLEY EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. Frank W. Broderick, 501 Central Trust Bldg., Sterling, Ill.
Secretary-Treasurer: Dr. Thorsten E. Blomberg, 501—7th St., Rockford, Ill.
Place: Rockford, Ill., or Janesville or Beloit, Wis. Time: Third Tuesday of
each month.

SAGINAW VALLEY ACADEMY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

President: Dr. W. K. Slack, 308 Eddy Bldg., Saginaw, Mich.
Secretary-Treasurer: Dr. Andre Cortopassi, 703 Second National Bank Bldg.,
Saginaw, Mich.
Place: Saginaw or Bay City, Mich. Time: Second Tuesday of each month,
except July and August.

SIoux VALLEY EYE AND EAR ACADEMY

President: Dr. J. H. Judd, 107 S. 17th St., Omaha, Neb.
Secretary-Treasurer: Dr. J. C. Decker, 515 Frances Bldg., Sioux City, Iowa.

SOUTHERN MEDICAL ASSOCIATION, SECTION ON EYE, EAR, NOSE AND THROAT

Chairman: Dr. Grady E. Clay, Medical Arts Bldg., Atlanta, Ga.
Secretary: Dr. John R. Hume, 921 Canal St., New Orleans.

SOUTHWESTERN MICHIGAN TRIOLOGICAL SOCIETY

President: Dr. John Hunter McRae, 26 Sheldon Ave., S. E., Grand Rapids, Mich.
Secretary-Treasurer: Dr. Dewey R. Heetderks, 405 Medical Arts Bldg., Grand
Rapids, Mich.
Time: Third Thursday of alternate months.

WESTERN PENNSYLVANIA EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. C. Wearne Beals, Weber Bldg., DuBois.
Secretary-Treasurer: Dr. C. Wearne Beals, Weber Bldg., DuBois.

STATE

COLORADO OPHTHALMOLOGICAL SOCIETY

President: A presiding officer is selected for each meeting alternately until all members have served.

Secretary: Dr. John C. Long, 324 Metropolitan Bldg., Denver.

Place: Capitol Life Bldg., Denver. Time: 7:30 p. m., third Saturday of the month, October to April, inclusive.

CONNECTICUT STATE MEDICAL SOCIETY, SECTION ON EYE, EAR,
NOSE AND THROAT

President: Dr. Charles T. Flynn, 41 Trumbull St., New Haven.

Secretary-Treasurer: Dr. Shirley H. Baron, 309 State St., New London.

Place: New London. Time: February 1938.

EYE, EAR, NOSE AND THROAT CLUB OF GEORGIA

President: Dr. John King, Thomasville.

Secretary-Treasurer: Dr. Mason Baird, 384 Peachtree St., Atlanta.

Place: Augusta. Time: May 1938.

INDIANA ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. E. E. Holland, 51 S. 8th St., Richmond.

Secretary: Dr. Marlow W. Manion, 23 E. Ohio St., Indianapolis.

Place: Indianapolis. Time: April 6, 1938.

IOWA ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. H. H. Lamb, American Bank Bldg., Davenport.

Secretary-Treasurer: Dr. B. M. Merkel, 604 Locust St., Des Moines.

Place: Davenport.

LOUISIANA-MISSISSIPPI OPHTHALMOLOGICAL AND OTOLARYNGOLOGICAL SOCIETY

President: Dr. C. A. McWilliams, G. and S. I. R. R. Bldg., Gulfport, Miss.

Secretary-Treasurer: Dr. Edley H. Jones, 1301 Washington St., Vicksburg, Miss.

Place: New Orleans. Time: Spring, 1938.

MICHIGAN STATE MEDICAL SOCIETY, SECTION OF OPHTHALMOLOGY
AND OTOLARYNGOLOGY

Chairman: Dr. F. N. Smith, Grand Rapids Clinic, Grand Rapids.

Secretary: Dr. Dewey R. Heetderks, 26 Sheldon Ave., S. E., Grand Rapids.

MINNESOTA ACADEMY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

President: Dr. Walter E. Camp, 1918 Medical Arts Bldg., Minneapolis.

Secretary-Treasurer: Dr. George E. McGeary, 920 Medical Arts Bldg., Minneapolis.

Time: Second Friday of each month from October to May.

MONTANA ACADEMY OF OTO-OPHTHALMOLOGY

President: Dr. Edward S. Murphy, Northern Pacific Hospital, Missoula.

Secretary: Dr. A. W. Morse, 507 Phoenix Bldg., Butte.

NEW JERSEY STATE MEDICAL SOCIETY, SECTION ON OPHTHALMOLOGY,
OTOLOGY AND RHINOLARYNGOLOGY

Chairman: Dr. Oram Kline, 414 Cooper St., Camden.

Secretary: Dr. James S. Shipman, 542 Cooper St., Camden.

NEW YORK STATE MEDICAL SOCIETY, EYE, EAR, NOSE AND THROAT SECTION

Chairman: Dr. Marvin F. Jones, 121 E. 60th St., New York.

Secretary: Dr. Algernon B. Reese, 73 E. 71st St., New York.

Time: May 10, 1938.

NORTH CAROLINA EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. J. M. Lilly, 302 Old St., Fayetteville.
 Secretary-Treasurer: Dr. Frank C. Smith, 106 W. 7th St., Charlotte.
 Place: Charlotte. Time: October.

NORTH DAKOTA ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. H. Rosenberger, 221—5th St., Bismarck.
 Secretary-Treasurer: Dr. F. L. Wicks, 514—6th St., Valley City.
 Place: Bismarck. Time: May 1938.

OREGON ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. A. B. Dykman, Medical Dental Bldg., Portland.
 Secretary-Treasurer: Dr. Andrew J. Browning, 418 Mayer Bldg., Portland.
 Place: Good Samaritan Hospital. Time: Third Tuesday of each month.

RHODE ISLAND OPHTHALMOLOGICAL AND OTOLOGICAL SOCIETY

Acting President: Dr. N. Darrell Harvey, 112 Waterman St., Providence.
 Secretary-Treasurer: Dr. Linley C. Happ, 124 Waterman St., Providence.
 Place: Rhode Island Medical Library. Time: 8:30 p. m., second Thursday in October, December, February and April.

SOUTH CAROLINA SOCIETY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

President: Dr. George Truluck, Orangeburg.
 Secretary: Dr. J. W. Jervey Jr., 101 Church St., Greenville.

TENNESSEE ACADEMY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

President: Dr. Kate Savage Zerfoss, 165—8th Ave., N., Nashville.
 Secretary-Treasurer: Dr. W. D. Stinson, 805 Medical Arts Bldg., Memphis.
 Place: Nashville. Time: April 12-13, 1938.

TEXAS OPHTHALMOLOGICAL AND OTO-LARYNGOLOGICAL SOCIETY

President: Dr. T. E. Fuller, 100 W. Board St., Texarkana, Texas.
 Secretary: Dr. O. M. Marchman, 1719 Pacific Ave., Dallas.

UTAH OPHTHALMOLOGICAL SOCIETY

President: Dr. V. P. White, 143½ S. Main St., Salt Lake City.
 Secretary-Treasurer: Dr. E. B. Fairbanks, Boston Bldg., Salt Lake City.
 Time: Third Monday of each month.

VIRGINIA SOCIETY OF OTO-LARYNGOLOGY AND OPHTHALMOLOGY

President: Dr. M. H. Hood, 505 Washington St., Portsmouth.
 Secretary-Treasurer: Dr. Charles T. St. Clair, 418 Bland St., Bluefield, W. Va.

WEST VIRGINIA STATE MEDICAL ASSOCIATION, EYE, EAR, NOSE
AND THROAT SECTION

President: Dr. George Traugh, 309 Cleveland Ave., Fairmont.
 Secretary: Dr. Welch England, 621½ Market St., Parkersburg.

LOCAL

ACADEMY OF MEDICINE OF NORTHERN NEW JERSEY, SECTION ON
EYE, EAR, NOSE AND THROAT

President: Dr. James A. Fisher, 501 Grand Ave., Asbury Park.
 Secretary: Dr. William F. McKim, 488 Sanford Ave., Newark.
 Place: 91 Lincoln Park South, Newark. Time: 8:45 p. m., second Monday of each month, October to May.

AKRON ACADEMY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

President: Dr. L. E. Brown, Second National Bldg., Akron.

Secretary-Treasurer: Dr. C. R. Anderson, 106 S. Main St., Akron.

Time: First Monday in January, March, May and November.

ATLANTA EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. J. Mason Baird, Medical Arts Bldg., Atlanta, Ga.

Secretary: Dr. Alton V. Hallum, 478 Peachtree St., Atlanta, Ga.

Place: Academy of Medicine, 38 Prescott St. Time: Second Friday of each month from October to May.

BALTIMORE MEDICAL SOCIETY, SECTION ON OPHTHALMOLOGY

Chairman: Dr. Henry F. Graff, 513 N. Charles St., Baltimore.

Secretary: Dr. Frank B. Walsh, Wilmer Institute, Johns Hopkins Hospital, Baltimore.

Place: Medical and Chirurgical Faculty, 1211 Cathedral St. Time: 8:30 p. m., fourth Thursday of each month from October to May.

BROOKLYN OPHTHALMOLOGICAL SOCIETY

President: Dr. Walter V. Moore, 1 Nevins St., Brooklyn.

Secretary-Treasurer: Dr. Mortimer A. Lasky, 1 Nevins St., Brooklyn.

Place: Kings County Medical Society Bldg., 1313 Bedford Ave. Time: Third Thursday in February, April, May, October and December.

BUFFALO OPHTHALMOLOGIC CLUB

President: Dr. Ivan J. Koenig, 40 North St., Buffalo.

Secretary-Treasurer: Dr. Meyer H. Riwchun, 367 Linwood Ave., Buffalo.

Time: Second Thursday of each month.

CHATTANOOGA SOCIETY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

President: Each member, in alphabetical order.

Secretary: Dr. A. H. Benz, 706 Medical Arts Bldg., Chattanooga.

Place: Mountain City Club. Time: Second Thursday of each month from September to May.

CHICAGO OPHTHALMOLOGICAL SOCIETY

President: Dr. Thomas D. Allen, 122 S. Michigan Blvd., Chicago.

Secretary-Treasurer: Dr. Earle B. Fowler, 55 E. Washington St., Chicago.

Place: Medinah Michigan Avenue Club, 505 N. Michigan Ave. Time: Third Monday of each month from October to May.

CINCINNATI OPHTHALMIC CLUB

Chairman: Each member, in rotation.

Secretary-Treasurer: Dr. E. R. Thomas, 819 Carew Tower, Cincinnati.

Place: Holmes Memorial Library, Cincinnati General Hospital. Time: 8:15 p. m., third Monday of each month except June, July and August.

CLEVELAND ACADEMY OF MEDICINE, SECTION OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

Chairman: Dr. Webb Chamberlin, 7405 Detroit Ave., Cleveland.

Secretary: Dr. Walter H. Rieger, Hanna Bldg., Cleveland.

Place: Winton Hotel. Time: Fourth Friday of each month.

CLEVELAND OPHTHALMOLOGICAL CLUB

Chairman: Dr. Paul Moore, Republic Bldg., Cleveland.

Secretary: Dr. G. Leslie Miller, 14805 Detroit Ave., Cleveland.

Time: Second Tuesday in October, December, February and April.

COLLEGE OF PHYSICIANS, PHILADELPHIA, SECTION ON OPHTHALMOLOGY

Chairman: Dr. Charles R. Heed, 1205 Spruce St., Philadelphia.
 Clerk: Dr. Alexander G. Fewell, 1924 Pine St., Philadelphia.
 Time: Third Thursday of every month from October to April, inclusive.

COLUMBUS OPHTHALMOLOGICAL AND OTO-LARYNGOLOGICAL SOCIETY

Chairman: Dr. C. E. Silbernagle, 247 E. State St., Columbus, Ohio.
 Secretary-Treasurer: Dr. D. M. Johnson, 327 E. State St., Columbus, Ohio.
 Place: Deshler Wallick Hotel. Time: 6 p. m., first Monday of each month.

CORPUS CHRISTI EYE, EAR, NOSE AND THROAT SOCIETY

Chairman: Dr. Edgar G. Mathis, 416 Chaparral St., Corpus Christi, Texas.
 Secretary: Dr. E. King Gill, 416 Chaparral St., Corpus Christi, Texas.
 Time: Second Thursday of each month from October to May.

DALLAS ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. Lester H. Quinn, 4105 Live Oak, Dallas, Texas.
 Secretary: Dr. J. Dudley Singleton, 1719 Pacific Ave., Dallas, Texas.
 Place: Dallas Athletic Club. Time: 6:30 p. m., first Tuesday of each month from October to June. The November, January and March meetings are devoted to clinical work.

DES MOINES ACADEMY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

President: Dr. E. G. Linn, 604 Locust St., Des Moines, Iowa.
 Secretary-Treasurer: Dr. Grace Doane, 614 Bankers Trust Bldg., Des Moines, Iowa.
 Time: 7:45 p. m., third Monday of every month from September to May.

DETROIT OPHTHALMOLOGICAL CLUB

Chairman: Members rotate alphabetically.
 Secretary: Dr. William Fowler, 1424 Maccabee Bldg., Detroit.
 Time: 6:30 p. m., first Wednesday of each month.

EASTERN NEW YORK EYE, EAR, NOSE AND THROAT ASSOCIATION

President: Dr. J. D. Carroll, 102—3d St., Troy, N. Y.
 Secretary-Treasurer: Dr. Joseph L. Holohan, 330 State St., Albany.
 Time: Third Wednesday in October, November, March, April, May and June.

FORT WORTH EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. Van D. Rathgeber, 1012 Medical Arts Bldg., Fort Worth, Texas.
 Secretary-Treasurer: Dr. Charles R. Lees, 306 W. Broadway, Fort Worth, Texas.
 Place: Medical Hall, Medical Arts Bldg. Time: 7:30 p. m., first Friday of each month except July and August.

GRAND RAPIDS EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. Dewey R. Heetderks, 405 Medical Arts Bldg., Grand Rapids, Mich.
 Secretary-Treasurer: Dr. Robert G. Laird, 116 E. Fulton St., Grand Rapids, Mich.
 Place: Various local hospitals. Time: Third Thursday of alternating months, September to May.

HOUSTON ACADEMY OF MEDICINE, EYE, EAR, NOSE AND THROAT SECTION

President: Dr. L. Allen, 1215 Walker Ave., Houston, Texas.
 Secretary: Dr. George C. Farrish, 1625 Main St., Houston, Texas.
 Place: Medical Arts Bldg., Harris County Medical Society Rooms. Time: 8 p. m., second Thursday of each month from September to June.

INDIANAPOLIS OPHTHALMOLOGICAL AND OTOLARYNGOLOGICAL SOCIETY

President: Dr. C. P. Clark, 24 E. Ohio St., Indianapolis.

Secretary: Dr. Kenneth L. Craft, 23 E. Ohio St., Indianapolis.

Place: University Club. Time: 6:30 p. m., second Thursday of each month from October to May.

KANSAS CITY SOCIETY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. O. S. Gilliland, 1103 Grand Ave., Kansas City, Mo.

Secretary: Dr. John S. Knight, 1103 Grand Ave., Kansas City, Mo.

Time: Third Thursday of each month from September to May. The November, January and March meetings are devoted to clinical work.

LONG BEACH EYE, EAR, NOSE AND THROAT SOCIETY

Chairman: Dr. F. C. Hertzog, 117 E. 8th St., Long Beach, Calif.

Secretary-Treasurer: Dr. Ben K. Parks, 619 Professional Bldg., Long Beach, Calif.

Place: Professional Bldg. Time: Last Wednesday of each month from October to May.

LOS ANGELES SOCIETY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. Isaac H. Jones, 1930 Wilshire Blvd., Los Angeles.

Secretary-Treasurer: Dr. John P. Lordan, 2007 Wilshire Blvd., Los Angeles.

Place: Los Angeles County Medical Association Bldg., 1925 Wilshire Blvd. Time: 6:30 p. m., fourth Monday of each month from September to May, inclusive.

LOUISVILLE EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. J. S. Bumgardner, Heyburn Bldg., Louisville, Ky.

Secretary-Treasurer: Dr. Max Bornstein, Heyburn Bldg., Louisville, Ky.

Place: Brown Hotel. Time: 6:30 p. m., second Thursday of each month from September to May, inclusive.

MEDICAL SOCIETY OF THE DISTRICT OF COLUMBIA, SECTION OF
OPHTHALMOLOGY AND OTOLARYNGOLOGY

Chairman: Dr. Earle Breeding, 1801 I St., N. W., Washington.

Secretary: Dr. Elmer Shepherd, 1606—20th St., N. W., Washington.

Place: 1718 M St., N. W. Time: 8 p. m., third Friday of each month from October to April, inclusive.

MEMPHIS SOCIETY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

Chairman: Each member, in alphabetical order.

Secretary: Dr. Sam H. Sonders, Medical Arts Bldg., Memphis, Tenn.

Place: Eye Clinic of Memphis Eye, Ear, Nose and Throat Hospital. Time: 8 p. m., second Tuesday of each month.

MILWAUKEE OTO-OPHTHALMIC SOCIETY

President: Dr. Thomas A. Judge, 735 N. Water St., Milwaukee.

Secretary-Treasurer: Dr. John B. Hitz, 208 E. Wisconsin Ave., Milwaukee.

Place: University Club. Time: 6:30 p. m., second Tuesday of each month.

MINNEAPOLIS OPHTHALMOLOGICAL SOCIETY

Chairman: Each member, in alphabetical order.

Secretary: Dr. M. C. Pfunder, 645 Medical Arts Bldg., Minneapolis.

Place: Hennepin County Medical Society rooms. Time: 6:30 p. m., fourth Monday of each month, October to May, inclusive.

MONTGOMERY COUNTY MEDICAL SOCIETY

Chairman: Dr. A. G. Farmer, 1040 Fidelity Bldg., Dayton, O.

Secretary-Treasurer: Dr. Rome M. Webster, 663 Reibold Bldg., Dayton, O.

Place: Van Cleve Hotel. Time: 6:30 p. m., bimonthly, first Tuesday from October to June, inclusive.

MONTREAL OPHTHALMOLOGICAL SOCIETY

President: Dr. Stuart Ramsay, 1496 Mountain St., Montreal, Canada.
Secretary: Dr. J. Rosenbaum, 1396 St. Catherine St., W., Montreal, Canada.
Time: Second Thursday of October, December, February and April.

NASHVILLE ACADEMY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

Chairman: Dr. Gny Maness, 119—7th Ave., Nashville, Tenn.
Secretary-Treasurer: Dr. Andrew Hollabangh, Doctors Bldg., Nashville, Tenn.
Place: St. Thomas Hospital. Time: 8 p. m., third Monday of each month from October to May.

NEW ORLEANS OPHTHALMOLOGICAL AND OTOLARYNGOLOGICAL SOCIETY

President: Dr. R. H. Fisher, Chess and Checker Club, New Orleans.
Secretary-Treasurer: Dr. H. F. Brewster, 837 Gravier St., New Orleans.
Place: Eye, Ear, Nose and Throat Hospital. Time: Third Thursday of each month from October to June.

NEW YORK SOCIETY FOR CLINICAL OPHTHALMOLOGY

Chairman: Dr. James W. White, 15 Park Ave., New York.
Secretary: Dr. Rudolf Aebli, 30 E. 40th St., New York.
Time: 8:30 p. m., third Monday of every month from October to May, inclusive.

NEW YORK SOCIETY FOR CLINICAL OPHTHALMOLOGY

President: Dr. Mark J. Schoenberg, 1160 Park Ave., New York.
Secretary: Dr. Jesse Stark, 45 Park Ave., New York.
Place: Squibb Hall, 745—5th Ave. Time: 7 p. m., first Monday of each month from October to May, inclusive.

OMAHA AND COUNCIL BLUFFS OPHTHALMOLOGICAL AND
OTO-LARYNGOLOGICAL SOCIETY

President: Dr. A. J. Young, 107 S. 17th St., Omaha.
Secretary-Treasurer: Dr. Delbert K. Judd, 1020 Medical Arts Bldg., Omaha.
Place: Omaha Club, 20th and Douglas Sts., Omaha. Time: 6 p. m., dinner;
7 p. m., program; third Wednesday of each month from October to May.

OPHTHALMOLOGICAL SOCIETY OF THE UNIVERSITY OF PITTSBURGH

President: Dr. W. W. Blair, 121 University Pl., Pittsburgh.
Secretary: Dr. George H. Shuman, 351—5th Ave., Pittsburgh.
Time: Second Monday in November, January, March and May.

PASSAIC-BERGEN OPHTHALMOLOGICAL CLUB

President: Dr. John S. Van Winkle, 297 Broadway, Paterson, N. J.
Secretary-Treasurer: Dr. T. A. Sanfacon, 340 Park Ave., Paterson, N. J.
Place: Paterson Eye and Ear Infirmary. Time: 9 p. m., last Friday of every month, except June, July and August.

PHILADELPHIA COUNTY MEDICAL SOCIETY, EYE SECTION

Chairman: Dr. Sidney L. Olsho, 235 S. 15th St., Philadelphia.
Secretary: Dr. Edmund B. Spach, 1930 Chestnut St., Philadelphia.
Time: First Thursday of each month from October to May.

PITTSBURGH OPHTHALMOLOGICAL SOCIETY

President: Dr. Glendon E. Curry, Westinghouse Bldg., Pittsburgh.
Secretary: Dr. George H. Shuman, 351—5th Ave., Pittsburgh.
Place: Pittsburgh Academy of Medicine Bldg. Time: Fourth Monday of each month, except June, July, August and September.

RICHMOND OPHTHALMOLOGICAL AND OTO-LARYNGOLOGICAL SOCIETY

President: Dr. A. F. Bagby, Professional Bldg., Richmond, Va.
Secretary: Dr. Richard W. Vaughan, Medical Arts Bldg., Richmond, Va.
Place: Westmoreland Club. Time: 6 p. m., second Monday of each month from October to May.

ROCHESTER EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. R. E. Elliott, 78 S. Fitzhugh St., Rochester, N. Y.
 Secretary-Treasurer: Dr. Raphael Farber, 280 Monroe Ave., Rochester, N. Y.
 Place: Rochester Medical Association, 113 Prince St. Time: 8 p. m., third Monday of each month from October to May.

ST. LOUIS OPHTHALMIC SOCIETY

President: Dr. Lawrence T. Post, 508 N. Grand Blvd., St. Louis.
 Secretary: Dr. Leslie Charles Drews, 508 N. Grand Blvd., St. Louis.
 Place: Osear Johnson Institute. Time: Clinical meeting 5:30 p. m., dinner and scientific meeting 6:30 p. m., fourth Friday of each month from October to April, inclusive, except December.

SAN ANTONIO OPHTHALMOLO-OTO-LARYNGOLOGICAL SOCIETY

President: Dr. Oscar H. Judkins, 414 Navarro St., San Antonio, Texas.
 Secretary-Treasurer: Dr. Wilfred E. Muldoon, 414 Navarro St., San Antonio, Texas.
 Place: Bexar County Medical Library. Time: 8 p. m., first Tuesday of each month from October to May.

SAN FRANCISCO COUNTY MEDICAL SOCIETY, SECTION ON EYE,
EAR, NOSE AND THROAT

Chairman: Dr. Joseph W. Crawford, 490 Post St., San Francisco.
 Secretary: Dr. Russell Fletcher, 490 Post St., San Francisco.
 Place: Society's Bldg., 2180 Washington St., San Francisco. Time: Fourth Tuesday of every month except May, June, July and December.

SHREVEPORT EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. J. A. Wilkinson, Medical Arts Bldg., Shreveport, La.
 Secretary-Treasurer: Dr. W. L. Atkins, 940 Margaret Pl., Shreveport, La.
 Place: Shreveport Charity Hospital. Time: 7:30 p. m., first Monday of every month except July, August and September.

SPOKANE ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. Raymond A. Lower, 407 Riverside Ave., Spokane, Wash.
 Secretary: Dr. Louis A. Parsell, Paulsen Medical and Dental Bldg., Spokane, Wash.
 Place: Paulsen Medical and Dental Library. Time: 8 p. m., fourth Tuesday of each month except June, July and August.

SYRACUSE EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. Gordon D. Hoople, 110 Medical Arts Bldg., Syracuse, N. Y.
 Secretary-Treasurer: Dr. I. Herbert Katz, 212 Medical Arts Bldg., Syracuse, N. Y.
 Place: University Club. Time: First Tuesday of each month except June, July and August.

TORONTO ACADEMY OF MEDICINE, SECTION OF OPHTHALMOLOGY

Chairman: Dr. Samuel Mortimer Lyon, 122 Bloor St. W., Toronto, Canada.
 Time: First Monday of each month, November to April.

WASHINGTON, D. C., OPHTHALMOLOGICAL SOCIETY

President: Dr. G. Victor Simpson, 1710 Rhode Island Ave., N. W., Washington, D. C.
 Secretary-Treasurer: Dr. Frank D. Costenbader, 1726 I St., Washington, D. C.
 Place: Episcopal Eye, Ear and Throat Hospital. Time: 8 p. m., first Monday in November, January, March and May.

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PHYSICAL THERAPY IN OPHTHALMOLOGIC PRACTICE

SANFORD R. GIFFORD, M.D.

CHICAGO

I shall consider only a few phases of physical therapy and shall limit my remarks to procedures which have, or seem destined to have, a definite place in ophthalmologic practice.

PHOTOTHERAPY

Phototherapy may be considered briefly, since few recent advances have been made in this field. The indications for general phototherapy are well known, although ophthalmologists are likely to forget them. The object of this form of treatment is to produce repeated mild cutaneous reactions, with a resulting increase in the various bactericidal constituents of the blood and better utilization of calcium and vitamin D by the tissues. Such treatment is nearly always indicated in cases of phlyctenulosis when proper use of sunlight cannot be secured. With the use of a large mercury vapor or carbon arc lamp, one third of the surface of the body is irradiated at a sitting, the dose being chosen which will produce a slight erythema. Such treatments are given to other areas twice a week and repeated until from fifteen to twenty-five treatments have been given. Administration of calcium and vitamin D by mouth is a useful adjuvant to general phototherapy. In cases of any form of ocular inflammation affecting a person with poor general resistance, and especially in cases of uveitis considered to be tuberculous, general phototherapy may be of considerable value and should be employed more often. The same is true of that severe and intractable condition sclerosing keratitis.

Local phototherapy has not lived up to the expectations which were held for it fifteen years ago. A few ophthalmologists still uphold its efficacy in the treatment of severe corneal infections, such as serpent

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Read before the American Academy of Ophthalmology and Otolaryngology, Section on Ophthalmology, Chicago, Oct. 11, 1937.

ulcer. Many never use it, while others employ it in a relatively small number of cases, chiefly those of superficial corneal infection. At the 1928 meeting of the American Academy of Ophthalmology and Otolaryngology, in a résumé of phototherapy, and in my "Hand-Book of Ocular Therapeutics," I¹ gave reasons for discarding the procedure in the treatment of serpent ulcer, other deep corneal infections and inflammation of the posterior segment. On account of the complete absorption of ultraviolet rays by a thin layer of opaque tissue, it seemed that its only possible effect could be expected in superficial forms of keratitis, such as dendritic or herpetic ulcer, degenerative ulcers on the surface of old scars and the ulcers of trachoma. For many years I treated all ulcers of this type with the Birch-Hirschfeld uvioi lamp or with a home-made arc lamp embodying quartz lenses and a filter of Corning glass 958 A. With the former lamp, treatments of from five to eight minutes in duration were given daily, since even with such long exposures erythema is not produced. With the latter lamp, erythema is produced in about one minute; so treatments were limited to fifty seconds and given three times a week. The lesions were stained with fluorescein or a 1 per cent solution of bengal rose before such treatment. A distinct impression was obtained that the irradiation was of value in such cases, since ulcers usually healed after two or three such treatments, and occasionally after one. Other agents, however, such as iodine, were usually employed, so that healing could not with certainty be attributed to the irradiation. Also, there were a few cases in which healing did not occur with such treatment, other measures being necessary. One of these measures, roentgen therapy, will be discussed later. Experimentally, Gunderson could demonstrate no effect of ultraviolet rays on the herpes virus. Since most of these superficial ulcers heal after the use of chemical agents, and since results have apparently been obtained by roentgen therapy in cases in which the ulcers resisted phototherapy, the useful field for local phototherapy seems to be contracting further and further. It is probably not too much to say that the ophthalmologist who is familiar with the use of other agents, especially roentgen therapy in suitable cases, can dispense with local phototherapy entirely.

USE OF COLD

I should like to emphasize the tremendous value of cold when applied after certain operations, and a simple but effective way of applying it. Any one who will compare the results of alternate operations for squint with and without the application of cold as a routine measure can hardly fail to be impressed with the difference in the postoperative reactions.

1. Gifford, Sanford R.: *Tr. Am. Acad. Ophth.* **33**:195, 1928; *Hand-Book of Ocular Therapeutics*, Philadelphia, Lea & Febiger, 1937, p. 103.

Chemosis and congestion after operations for squint with the use of cold are minimal and in many cases almost entirely absent. The effect is even more striking after simple evisceration of the globe, while without the use of cold chemosis was always extreme and very persistent. In operations for ptosis, since the use of Friedenwald's procedure of protecting the cornea by the lower lid, it has become possible to use cold, and the results are well worth the trouble. The practical method of applying cold is that used in Dr. Loyal Davis' neurosurgical cases at the Passavant Hospital and is probably familiar to most physicians. Finely chopped ice is placed in a thin rubber glove, the fingers of which are tied off so that a small flexible bag is formed. This is covered by a single layer of thin gauze and applied to the closed lids, which may be covered by a single layer of sterile gauze if skin sutures have been employed. This treatment is carried out during the alternate waking hours; it is begun immediately after operation and continued for three or four days, as a rule. I have never seen any evidence of delayed healing or of damage to the corneal nutrition resulting from such use of cold. The effect on postoperative pain, as well as on chemosis, is often gratifying.

THERMAL THERAPY

Infra-Red Lamps.—Coulter has given experimental evidence indicating that greater heat may be produced in the tissues with infra-red lamps than with heating pads, and almost the same superiority probably holds when the heat of infra-red lamps is compared with that of moist hot packs. There are also practical reasons for preferring infra-red lamps for routine use in the hospital or the home. Such heat is clean and may be employed after operations without danger of infection. It avoids direct contact with the lids, which is of advantage in cases of recent operation or wound. The use of lamps lessens the amount of nursing care required, as compared with moist heat, since the patient is easily taught to adjust the lamp to the limit of skin tolerance. The more expensive infra-red lamps which are usually available in hospitals may be replaced by inexpensive models for use by the patient at home.

The indications for infra-red therapy include all forms of inflammation of the eyes and adnexa except those in which danger of hemorrhage exists. Other exceptions are glaucoma and the early stages of conjunctivitis in which swelling and chemosis might be increased. In cases of acute iritis, postoperative iritis, acute cellulitis and deep infection of the lids, heat is especially important and may be used almost continuously.

Diathermy.—Heat generated by electrical energy in the tissues will be discussed only in its nonsurgical aspects. Reports on the use of

local nonsurgical long wave diathermy in the treatment of ocular diseases have been numerous, and a variety of conditions have been treated, as shown in a recent review by Nugent.² Coulter has compared the efficacy of long wave diathermy with that of short wave therapy. He has shown that with both methods higher temperatures can be produced in the deeper tissues of the eye and orbit than is possible with infra-red lamps. With the short wave method the higher temperatures may be reached more quickly and with less danger of burning the skin. With the glass electrodes now in use the effect may be fairly well localized. It is not known exactly what temperatures are tolerated by the normal ocular tissues without producing permanent degenerative changes. Hoffmann and Kunz³ found that at 43.5 C. (110.3 F.) marked circulatory changes occurred in the choroid, including hemorrhages. At from 42 to 43 C. (107.6 to 109.6 F.) the retinal ganglion cells showed edema and degenerative changes. Opacities of the lens were seen only with somewhat higher temperatures after one exposure, but the effect of repeated exposures was not determined. The duration of Hoffmann and Kunz's experiment was from fifteen to twenty-five minutes, the maximal temperature being maintained for ten minutes.

It would seem unwise to raise the temperature inside the eye much above 105 F. (40.5 C.), since the danger of hemorrhage must be considered as probably greater in eyes with inflammatory conditions or disease of the blood vessels.

The difficulty in obtaining a dose which will assure this limit of temperature is at once evident. All that can be done is to imitate closely the technic with which the desirable temperature has been obtained in experimental work and that which has been employed in a large number of cases by reliable observers without causing detectable damage to the eye. Kokott⁴ employed Siemen's ultratherm, which generates waves of 6 meters, the electrodes being placed in contact with the skin and 2 cm. apart. He employed the technic recommended by the manufacturers for therapeutic work. The highest temperatures were obtained in the vitreous, an increase of 4.8 degrees C. (8.6 degrees F.) occurring in ten minutes and only slightly more after fifteen minutes. This temperature would approximate 107.2 F. Heating was less in the orbit, the increase averaging 2.9 degrees C. (5.2 degrees F.) in contrast to 4.8 degrees C. in the vitreous. There was some variation in the temperatures produced in various animals. Kokott expressed the belief that exposures of ten minutes are long enough to produce a practical maximum of heating without certain dangers of longer exposures, especially that of pro-

2. Nugent, O. B.: *Arch. Phys. Therapy* **17**:234, 1936.

3. Hoffmann, W., and Kunz, E.: *Arch. f. Ophth.* **132**:155, 1934.

4. Kokott, W.: *Klin. Monatsbl. f. Augenh.* **97**:448, 1936.

ducing cerebral disturbances. He obtained some burns with this technic and advised that more exact dosage and localization of the current are desirable.

Puntenney and Osborn, in some work now being conducted at Northwestern University, a report of which will be published later, obtained results which agreed in most essentials with those of Kokott. With the same instrument, the glass electrodes being placed one over the eye and the other back of the neck, the temperature in the vitreous was raised within twenty minutes to from 107 to 109 F. Cooling from the highest point occurred rapidly after the current was turned off, the temperature reaching to 103 or 104 F. within twenty minutes and usually returning to normal within one hour. The body temperature was considerably higher than in Kokott's experiment, but in most animals it remained an average of 3 degrees F. lower than that of the vitreous. When the two electrodes were placed on either side of the eye such high temperatures were not obtained, the maximum being 106.7 F. and the average 103 F. Cooling also occurred much more quickly with this technic. With a ten minute exposure, almost the same temperature could be reached, but cooling was much more rapid. Careful measurement of the retinal vessels by Lambert's method revealed no actual dilatation of the larger vessels in any animal, which is in contradiction to the impression gained by many observers from their ophthalmoscopic findings. This method is accurate, certainly more so than the usual impression obtained from the ophthalmoscopic picture. It does not exclude, of course, dilatation in the capillary bed. Individual differences between animals were considerable, and it certainly cannot be stated that the same temperatures could be produced in man by approximately the same technic; so direct observation on human eyes before enucleation is desirable and is being undertaken. The temperatures here recorded, while higher than some of those with which Hoffmann and Kunz observed damage to retinal structures, were not maintained so long as in their experiments.

Of clinical reports, that of Gutsch⁵ gives his experience in treating two hundred and seventy-six patients with ocular disease. He employed the same machine as Kokott did, using glass shell electrodes held from 1 to 3 cm. from the globe, with exposures beginning at from six to eight minutes and being increased to fifteen minutes in certain cases. Treatments were given two or three times a week. He saw no evidence of damage in any case. He saw no definite beneficial effect in cases of corneal disease, glaucoma or scleritis, and the effects in cases of acute iritis were doubtful. He was impressed by the benefits obtained in

5. Gutsch, N.: *Ber. ü. d. Versamml. d. deutsch. ophth. Gesellsch.* **51**:221, 1936.

cases of chronic iridocyclitis, especially the tuberculous form, and in cases of vascular disease of the fundus. In three cases of conglomerate tubercle of the iris and two of conglomerate tubercle of the choroid the lesions disappeared rapidly under treatment. In cases of acute orbital cellulitis and acute dacryocystitis the inflammation subsided rapidly. Wegner, in discussing Gutsch's paper, reported no results in cases of chronic uveitis and stated that he saw a retinal hemorrhage occur after treatment. Scheyhing⁶ employed a similar technic and reported good results in various inflammatory conditions, but gave few details. In brief clinical reports, Carlotti⁷ and Kuwahara⁸ also claimed good results for the method. The report of Krause⁹ is chiefly clinical but includes observations on rabbits treated for ten successive days with the usual dose. No damage to the eyes was noted. The best clinical results were obtained in infection of the lids and dacryocystitis, in which conditions resolution occurred with striking rapidity. In one case of postoperative iritis with hypopyon the lesions cleared up rapidly under treatment. No results were seen in cases of sympathetic ophthalmia or of disciform keratitis. Krause reviewed the observations of de Decker and Arendt, Grüter, Sattler and Bartels, from which it is difficult to draw conclusions since the best results were obtained in cases of herpetic keratitis of the superficial variety, in which healing often occurs rapidly with other treatment. Results in cases of interstitial keratitis were not definite. Kiewe¹⁰ recorded the temperatures produced by various methods, but details are not given in the available reports of his work.

A number of observers were convinced that dilatation of the retinal vessels could be seen following treatment, but no accurate measurements were made.

In the country, Walker¹¹ has employed short wave diathermy for patients with opacities of the vitreous following operations for detachment and due to other causes. The apparatus used by him delivers 1,500 milliamperes with small oval electrodes suspended over the eye, and the current is applied for fifteen minutes, with intervals of a minute or so every three minutes. He has seen no burns by this method but stated that care must be taken with more powerful machines. He expressed the belief that the method should be more widely employed by ophthalmologists and that it is of especial value in the treatment of glaucoma secondary to uveitis.

6. Scheyhing, H.: *Klin. Monatsbl. f. Augenh.* **98**:387, 1937.

7. Carlotti: *Klin. Monatsbl. f. Augenh.* **98**:575, 1937.

8. Kuwahara, Y.: *Klin. Monatsbl. f. Augenh.* **98**:576, 1937.

9. Krause, J.: *Ztschr. f. Augenh.* **89**:266, 1936.

10. Kiewe, P.: *Klin. Monatsbl. f. Augenh.* **95**:108, 1935.

11. Walker: *Tr. Am. Ophth. Soc.* **33**:71, 1935.

It may be concluded that short wave therapy is the most efficient method known of producing heat in the deeper tissues and that it is probably of real value in cases of severe infection of the lids and orbit or of acute dacryocystitis and in certain cases of chronic uveitis. It must be used with care to prevent burns, and further observations as to exact dosage are desirable. It would seem to be contraindicated in cases in which the danger of hemorrhage exists.

FEVER INDUCED BY LONG OR SHORT WAVE DIATHERMY

There can be no doubt that when fever therapy is indicated, the increase in temperature can be efficiently and constantly obtained by diathermy. The blankets with which long wave diathermy was employed have rather generally been replaced by cabinets in which a field of short wave current is generated while the patient is kept dry by the passage of air. The desired temperature can be produced more rapidly in such cabinets than in those employing air conditioning alone. Even when every precaution is taken to replace lost fluid and salt during the treatments, the method is not without danger. Hence it should be reserved for serious conditions which do not respond to other forms of therapy and must not be employed for elderly or infirm patients, especially if increased blood pressure or myocardial lesions are present. It is the routine at the Passavant Hospital to require an electrocardiographic examination in addition to a thorough physical examination before fever therapy in the cabinet is given. The treatment must be supervised throughout by an assistant who is thoroughly familiar with the method and with complicating conditions which may arise during treatment.

Three conditions seem to offer special indications for this form of therapy. The most important of these is gonorrheal ophthalmia in the adult. Pinkerton¹² has reported excellent results in three cases with a temperature of 107 F. maintained for from five to ten hours. Swelling and secretion subsided promptly, and smears became negative twenty-four hours after the first treatment. In two cases corneal ulcers were present when treatment was begun and healed promptly. While no other reports have been seen, the success of the method with other forms of gonorrhea and the severity of the process under former methods of treatment seem to offer a definite indication for the method. Results in the few cases available seem to be definitely superior to those obtained by the usual foreign protein therapy.

The second of the three conditions mentioned is interstitial keratitis. The most complete report on the subject is by Culler and Simpson.¹³

12. Pinkerton, F. J.: *Am. J. Ophth.* 20:63, 1937.

13. Culler, A. M., and Simpson, W. M.: *Artificial Fever Therapy in Cases of Ocular Syphilis*, *Arch. Ophth.* 15:624 (April) 1936.

They employed the Kettering hypertherm, an air-conditioned cabinet, producing a temperature of 105 F., which was maintained for five hours. Weekly treatments were given for ten weeks, each treatment being preceded by an injection of bismarsen. They observed eleven patients with twenty affected eyes for eighteen months or longer. At the end of this time no patient had vision of less than 6/30, while vision in eighteen eyes was 6/12 or better. The average period of congestion for the treated patients was two months. Eight of the patients treated had suffered recurrences after other treatment, and ten had failed to respond to chemotherapy. It will be noted that the degree and duration of temperature employed in this series were both considerably less than those used in treating gonococcic infections.

The third condition in which fever therapy seems indicated is atrophy of the optic nerve in syphilis of the central nervous system. Culler and Simpson reported on sixteen patients treated by the same method employed in the cases of interstitial keratitis. Central vision remained the same in practically all cases, and the fields increased in three. A number of cases in which malarial inoculations were used have been reported by Fischer-Ascher, Heinsius, Gasteiger, Clark and others. In general, the results were encouraging to the employment of fever, and the advantages of fever produced in the cabinets over malarial inoculations are obvious. Neymann¹⁴ treated seven patients with syphilitic atrophy of the optic nerve, employing a temperature of 107.6 F. for eight hours. Treatments were given twice a week for ten weeks. Three patients in whom the condition was advanced became blind. Two showed slight improvement in vision, while in two the disease remained unchanged. In most of his cases the condition was advanced when treatment was begun. When compared with the method of cisternal injections, results in a limited number of cases appear more favorable with the latter method, but it must be considered as more dangerous than fever therapy.

On account of the necessary nursing care and the dangers involved, it seems best to reserve high fever therapy for the three conditions just mentioned. Culler and Simpson reported good results in cases of syphilitic iritis, and Whitney¹⁵ used the method in cases of various types of keratitis and iritis, but there seems reason to think that equally good results could have been obtained by simpler methods. The use of a lower temperature (105 F.) and a shorter period (four hours) may

14. Neymann, C. A.: *Artificial Fever Therapy*, Springfield, Ill., Charles C. Thomas, Publisher, 1937.

15. Whitney, E. L.: *Artificial Fever Therapy in Treatment of Corneal Ulcer and Acute Iritis*, J. A. M. A. **104**:1794 (May 18) 1935.

prove of advantage in certain cases of intractable chronic uveitis, the dangers of such a temperature being negligible when proper precautions are taken.

ROENTGEN THERAPY

Roentgen therapy has been mentioned as having proved valuable in the treatment of certain types of keratitis. The rationale of the method, in which doses so small as to be perfectly safe are employed, is not clear. It is improbable that bacteria are killed, although there is some evidence that the herpes virus is especially susceptible to roentgen irradiation. It is more likely, as Case suggests, that leukocytes, which are extremely sensitive to roentgen irradiation, are broken down in the tissues, with the liberation of ferments and lytic substances which aid in the body's defensive reaction. Cells involved in the healing of corneal defects may also be stimulated. It is hard to bring scientific proof of such phenomena. Clinical experience, however, has convinced me that one or two exposures to a small dose of roentgen rays may be of great value in the treatment of dendritic ulcer, superficial punctate keratitis, degenerative ulcers or old scars and a few other types of keratitis. Such treatments have been given for me by Dr. James Case in ten cases, chiefly of dendritic keratitis, in most of which the condition had resisted other treatment or had recurred after such treatment. Most of these ulcers healed within one or two days of the first treatment, and a second was seldom required. In no case has any evidence of damage to the lens been seen, which is what could be expected from such small doses. Such treatments are given, of course, without any form of protective shell. From 80 to 90 roentgens of unfiltered radiation with a current of 100 kilovolts was given at each treatment.

Roentgen therapy is of great value in severe cases of blepharitis. Three doses of from 80 to 90 roentgens each are given at intervals of two weeks, a mercury-filled glass or a lead shell being placed beneath the lids to protect the cornea and lens. Blepharitis of many years' standing which has resisted the usual forms of treatment has practically always responded to this treatment. The use of a mild ointment, usually of 2 per cent zinc oxide in hydrous wool fat, is used for some time to dissolve crusts and prevent recurrences. In a few cases a second course of treatment has been necessary after a year or more. Such dosage has never caused loss of lashes in my cases, and no damage to the lens has been observed.

In a few cases of early postoperative and posttraumatic infection results have been encouraging enough to deserve mention, although the number of cases is too small to justify definite conclusions.

SUMMARY

Phototherapy is probably of value in herpetic and a few other forms of superficial keratitis.

Roentgen irradiation in small doses has apparently produced good results in cases of keratitis in which phototherapy has failed and may well replace phototherapy in the treatment of conditions for which it has been employed.

The infra-red lamp is a useful and practical instrument for applying ordinary heat.

Local short wave diathermy may prove to be of considerable clinical value in the treatment of chronic uveitis and of cellulitis of the lids and orbit. Standardization of dosage is desirable.

General fever therapy by the use of diathermy cabinets is of value in cases of gonorrheal ophthalmia, interstitial keratitis and syphilitic atrophy of the optic nerve.

Roentgen therapy is of undoubted value in cases of obstinate blepharitis, dendritic keratitis or superficial punctate keratitis in its more severe forms and possibly in cases of disciform keratitis.

USE OF TYPHOID H ANTIGEN BEFORE INTRA-OCULAR OPERATIONS

ALBERT L. BROWN, M.D.

CINCINNATI

A method of rapidly producing and increasing the antibody titer of the blood by the intravenous administration of typhoid H antigen has been recently described. The beneficial effect of an increased intra-ocular concentration of H antibodies on intra-ocular inflammation has likewise been reported.¹ Briefly, the titer of the blood may rise to 1:100+ in from forty-eight to fifty hours after an intravenous injection of a solution of typhoid H antigen containing 15,000,000 organisms. At this time the titer of the aqueous is usually not measurable. After paracentesis of the anterior chamber, the titer rises to 1:6 or 1:8. This concentration was found to have an inhibiting power on the production of experimental iritis in sensitized rabbits. Higher concentrations could be obtained by further tapplings, with consequently greater inhibiting power. This method was applied clinically to patients with various types of uveal inflammation, with marked benefit beyond that previously obtained in the same persons with other accepted local and general procedures.

Use of the same idea in intra-ocular operations as a possible prophylaxis against postoperative inflammation, especially of the uveal tract, was considered logical. It was noticed in rabbits that when the antibody concentration of the aqueous was raised *before* sensitization the inhibiting effect was greater than when it was done after sensitization. The effect was also greater when the titer was raised in the aqueous *before* the activating dose was administered.² The aqueous titer in patients with uveitis can be raised only after the activation or onset of disease, because the inflammation is treated only after it occurs. However, when an intra-ocular operation is proposed, the inflammation may be anticipated and the typhoid H antigen given intravenously from forty-eight to seventy-two hours before the operation; the antibody titer of the aqueous is raised automatically by the ocular incision which releases aqueous. The new aqueous formed after closure of the wound is necessarily rich in H antibodies derived from those already formed in the blood by the previous intravenous injection.

1. Brown, A. L.: Am. J. Ophth. 20:583 (June) 1937.

2. Brown, A. L.: Tr. Am. Ophth. Soc. 33:435, 1935.

For the past three years this method has been used before intra-ocular operations. At first it was applied only in cases in which post-operative inflammation was feared. The effect was so uniformly good that the procedure was extended to practically all cases, for there seemed to be no contraindication to the dosage used except in aged persons with many degenerative changes who were considered unable to stand any protein shock that might occur. During the latter part of the first year the prophylactic injection was given to all patients before an intra-ocular operation. Since uveal inflammation is infrequent after most operations for glaucoma simplex, the injection was reserved for persons requiring operation for secondary glaucoma, especially those with glaucoma due to uveitis and associated with synechiae, those requiring iridotomy or those showing untoward reactions on a previous occasion.

All patients with cataract are so treated. Verhoeff's and Lemoine's³ theory of the causation of endophthalmitis after an extracapsular extraction for cataract deals with the probable sensitization to lens cortex, which when released in the anterior chamber activates the eye to inflammation. If this is sound, the enriching of new postoperative aqueous with potent antibodies that inhibit activation is a logical prophylaxis. Whatever the mechanism, this method has shown itself a valuable adjunct in a hundred cases of cataract in which extraction was done, in fifty by the extracapsular method. From fifty to seventy-two hours before operation the patient is given a minim (0.06 cc.) of a solution of typhoid H antigen (25,000,000 organisms to 1 cc.) intradermally. If there is no local reaction within twenty to thirty minutes, a solution containing 15,000,000 organisms is injected intravenously. This may be done at the office and the patient instructed to go home because a reaction may ensue within four to eight hours. Sixty per cent of the patients feel nothing beyond a mild indefinite discomfort; 20 per cent report a slight chilly sensation followed by mild muscular soreness the next day. Twenty per cent suffer from shock, having malaise, chills and fever, with temperature as high as 103 F., which subsides in from two to four hours, leaving them with muscular aches described as "a grippy feeling." These patients do not object to the reaction when the purpose of the therapy is explained. The hundred cases in which this method was used are not reported in detail because postoperative inflammation occurred in but one case. In this case it appeared three days after an apparently uneventful recovery, accompanied by violent pain, redness and a peculiar clouding of the stroma of the cornea from below and extending upward. The tension rose on the fourth day to 55 mg. (Schiötz). The anterior chamber was tapped, and the tension

3. Verhoeff, F. H., and Lemoine, A. N.: *Internat. Cong. Ophth.* 1:234, 1922.

subsided. The eye remained irritated, but with normal tension, for four weeks thereafter. At the time of the writing of this report the corneal haze had persisted for six months but seemed to be slowly clearing. It is possible that in this case the posterior layer of the cornea was injured during operation.

When an eye is perforated accidentally in any manner, typhoid H antigen is immediately given intravenously after a negative cutaneous test. If the wound is purely ocular, the preference is given to the antigen rather than to antitetanic serum, unless there is a definite reason to fear the material coming in contact with the patient at the time of injury. If there are extensive wounds in the skin beside the ocular injury, the treatment depends on the circumstances. The serums have not been given together, but this may be feasible.

OCULAR MANIFESTATIONS OF ENDOCRINE DISTURBANCE

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Although much is known about the functions of the endocrine glands, their study still remains the most fertile field for advancement in medicine. The actions of these glands are so greatly influenced by environment, vitamins, chemicals and emotional states that the results of animal experimentation are not conclusive. The action of one gland is so intimately bound up with the actions of all the other glands that it is almost impossible to isolate hyperfunction or hypofunction of any single gland. In an effort to make up for the deficiency of a hypofunctioning gland, other glands may develop hyperfunction of their primary secretions or of their component glands. Then the vitamins, which are to plant life what the hormones are to animal life, are essential to the proper functioning of the endocrine system. Finally, biochemical reactions and the nervous system regulate the endocrine function, and the endocrine function controls the biochemical process and the nervous system.

Because of this complexity and the interrelation of the various endocrine glands, the nervous system and the biochemical processes, it can readily be seen that the clinical symptoms and physical characteristics render the most reliable information applicable to clinical medicine.

Because of the facility of studying directly under magnification the living ectoderm, mesoderm and, to a lesser degree, entoderm, and because of the dual control system of the vagus and sympathetic nerves, the eye provides an excellent medium for the study of endocrine disturbances.

Since such a field is available for the study of endocrine disturbances, it behooves the ophthalmologist to train himself to recognize the various signs of endocrine malfunction in order better to qualify himself as a consultant in and a practitioner of ophthalmology.

No effort will be made to review the extensive literature, as that has been done completely by von Szily¹ and Velhagen.²

Read at a meeting of the American Academy of Ophthalmology and Otolaryngology, Chicago, Oct. 14, 1937.

1. von Szily, A.: On the Pathological Relation of the Visual Organs to Endocrine System, *Zentralbl. f. d. ges. Ophth.* **33**:161, 1935; About Different Eye Diseases Which Are Thought to Be Related to Endocrine Disease, *ibid.* **34**:193, 1935.

(Footnote continued on next page)

The autonomic nervous system is so intimately associated with the function of the endocrine system and the eye that a brief review is essential to a clear understanding of the action of the endocrine glands in relation to the eyes. The autonomic nervous system is not an independently controlled nervous system but an involuntary outflow from the cerebrospinal nervous system with peripheral plexuses at the sites of distribution which are connected by neurons to the cerebrospinal system. These are subdivided into the sympathetic, parasympathetic and visceral systems. The sympathetic system comprises the thoracolumbar outflow, while the parasympathetic system includes the cranial and sacral outflows.

Hyperstimulation of the parasympathetic system (vagotonia) results in an increase in salivation, perspiration and lacrimation, dermal and vasomotor changes and motor reactions, manifested by contraction of the pupils, spasm of accommodation, contraction of the respiratory tract, spastic colon and rectal tenesmus, while hyperstimulation of the sympathetic system results in a decrease in lacrimation, perspiration and salivary secretion, dilatation of the pupil, an increase in the pulse rate and colonic-rectal atony. In other words, the sympathetic and the parasympathetic system when supplying the same organ act antagonistically. Some organs are supplied only by the sympathetic system, and in these the sympathetic nerves have an added mild parasympathetic action.

The adrenal medulla, the anterior lobe of the pituitary gland, the thyroid gland and the gonads stimulate the sympathetic nervous system, while the posterior lobe of the pituitary gland and the adrenal cortex stimulate the parasympathetic system. Pilocarpine stimulates the vagus system, while atropine paralyzes its terminals.

Before one attempts to attribute any ocular manifestation to an endocrine disturbance, other disease entities should be sought for and eliminated, because in the presence of any other disease one is not justified in making a definite diagnosis of endocrine disease.

Determinations of the blood sugar, nonprotein nitrogen, urea, calcium, uric acid, cholesterol and chlorides are of value in arriving at a diagnosis. For the blood sugar is affected by the pancreas and the thyroid, adrenal and pituitary glands; the nonprotein nitrogen, urea, uric acid and creatinine, by the adrenals, the thyroid and the pancreas; calcium, by the parathyroid, and cholesterol, by the thyroid.

2. Velhagen, K., Jr.: Observations on Disturbances of the Endocrine System and the Eye, *Klin. Monatsbl. f. Augenh.* **96**:577, 1936. von Szily, A.: Disturbances of the Endocrine Secretions and Their Effects on the Eye, *Zentralbl. f. d. ges. Ophth.* **32**:97, 1934.

THYROID GLAND

Of all the endocrine glands, the function of the thyroid is best known, and apparently any deviation from the normal most frequently affects the eyes, either because it is more frequently recognized or because it has a greater influence on the appearance of the eye.

The internal secretion of the thyroid gland assists in the stimulation of the sympathetic nervous system and mentality and acts as a catalytic substance, expediting metabolic processes and facilitating chemical changes in all the cells of the body, especially reactions involving iodine, calcium, sodium chloride and phosphorus. It influences the function of the pancreas, the pituitary gland and the gonads.

As is well known, the basal metabolic test is unreliable unless several tests are made. The determination of the cholesterol content of the blood is perhaps more reliable, as the value is low in cases of hyperthyroidism and high in cases of hypothyroidism. However, the cholesterol content is also increased by an excess of vitamin D and lowered by a deficiency of vitamin D. Because of this unreliability of laboratory procedures, recognition of the ocular signs of dysfunction of the thyroid gland is of great importance in arriving at a diagnosis.

The most striking ocular sign of hyperthyroidism is exophthalmos, usually binocular. This is due to a round cell infiltration and edema of the muscles and orbital tissues. In some cases the exophthalmos is aggravated by thyroidectomy. In such cases the condition seems to be due to hyperadrenalism, and Crile has brought about relief in many of them by denervation of the adrenal gland. If the exophthalmos is not relieved, lagophthalmic keratitis may develop, resulting in troublesome ulcers or loss of the eyes.

Other ocular signs associated with hyperthyroidism, alone or in conjunction with exophthalmos, are: Graefe's sign, failure of the lids to follow the downward motion of the globe; Stellwag's sign, diminution in the frequency of blinking; Dalrymple's sign, deficiency of convergence, and Gifford's sign, a transverse ridge on eversion of the upper lid due to spasm of the orbicularis muscle. These signs are all the result of hyperstimulation of the sympathetic nervous system. There may also be muscular paralysis or heterophoria as the result of pressure and dilatation of the pupils due to hyperstimulation of the sympathetic system.

In cases of hypothyroidism the skin of the lids is edematous, the eyebrows and eyelashes are sparse and brittle, and there may be marginal blepharitis, eczema and chronic conjunctivitis. Enophthalmos may be present. In an occasional case nystagmus has been ascribed to hypothyroidism. In cases of marked hypothyroidism there is a yellowish fold of edematous conjunctiva in the lower cul-de-sac. Lacrimal secre-

tion is diminished, and the frequency of blinking and squinting is increased, in some cases markedly. Syphilitic interstitial keratitis occurs much more frequently in patients with hypothyroidism than in those with normal thyroid function, and the excellent and rapid results obtained in such patients with fever therapy are most likely due to stimulation of the thyroid and adrenal glands, which in turn stimulate the reticulo-endothelial cells. Myopia and opacities of the lens are frequently associated with hypothyroidism. Multiple noninfected chalazia are frequently the result of this condition. I have found the incidence of hypothyroidism high in cases of cortical cataract. Strabismus has frequently been found associated with hypothyroidism.

I have found that hypothyroidism may easily be overlooked in the children of the more prosperous classes. It should always be suspected in children with chronic eczema or catarrh.



Photograph of the fundus illustrating edema of the retina as seen in cases of hypothyroidism.

I have associated with hypothyroidism a sign not previously reported, viz.: edema of the retina around the disk and macula, extending into the retina as much as 4 or 5 disk diameters. I have found the disk elevated as much as 3 diopters and the vision reduced to 20/40 by this edema. At first this condition was attributed to allergy, but in a number of cases it was not possible to demonstrate allergy to any known allergen. Further investigation demonstrated deficient function of the thyroid gland in most of the nonallergic patients. In addition, I was able to demonstrate such a deficiency in most of those in whom allergy was present.

The only reference found relative to retinal changes associated with hypothyroidism was by Engelbach,³ who stated: "The retinal signs present in some cases of myxoedema are often thought to be albuminuric retinitis." His description represents the condition as found in patients with severe edema of the retina, but in those with mild edema a low

3. Engelbach, W.: *Endocrine Medicine*, Springfield, Ill., Charles C. Thomas, Publisher, 1932, vol. 3, p. 325.

grade hyperthyroidism can usually be confirmed by several basal metabolic tests, determination of the cholesterol content of the blood and a therapeutic test.

PARATHYROID GLANDS

The parathyroid glands control the metabolism and assimilation of calcium and phosphorus, which act as a sedative to the irritating effects of sodium on the nerves of the voluntary and involuntary muscles. Consequently, with deficiency of the secretion of the parathyroid glands, symptoms of calcium deficiency develop, that is, increased muscular rigidity with fine tremors of the voluntary and involuntary muscles. This deficiency has been termed *diabetes calcareus*. It has been suggested that vitamin D may have a part in regulating the function of the parathyroid glands.

I have observed no ocular manifestations of hyperparathyroidism. Lack of secretion of the parathyroid glands disturbs calcium metabolism, resulting in a vagotonic activation of muscle tissues, and may be reflected in clinical ophthalmology as ciliary spasm, blepharospasm and idiopathic spastic entropion, twitching movements of the lids and eyeballs and hypersecretion of tears. The calcium disturbance may produce zonular cataract. There is a close association between cataract and parathyroid tetany in children. I have seen strabismus unassociated with refractive errors develop during convulsions which most likely were the results of acute hypoparathyroidism, since 90 per cent of convulsions in children before 2 years of age are due to this condition.

PITUITARY GLAND

The anterior lobe of the pituitary gland regulates growth and development and has a great influence on the gonads, the mammae and the thyroid and adrenal glands. It stimulates the sympathetic nervous system and assists in the metabolism of protein, fats, water calcium, etc. After removal of the anterior lobe, the adrenal cortex and gonads atrophy. Part of its action on the eye is through its effects on the sympathetic and parasympathetic nervous systems.

Opacities of the lens are seen in conditions due to hyperfunction, such as acromegaly. During pregnancy there is a physiologic enlargement of the pituitary gland, causing bitemporal contraction of the visual field. When there is marked enlargement of the pituitary gland the fields usually show bitemporal hemianopia and occasionally atypical defects. Contrary to the general belief, pathologic enlargement of the pituitary gland does not always produce bitemporal contraction, but one or both fields may be concentrically contracted, or, if only the posterior lobe is enlarged, one of the optic tracts may be involved, with the production of homonymous hemianopia. These changes are asso-

ciated with blurred vision or anisometropia, with swelling of the optic disk and, eventually, with secondary atrophy of the optic nerve. With most of these enlargements there is more or less headache. In cases of lower skull, which usually is associated with hyperpluitarism, the orbit and the optic foramen are contracted. In minor disturbances there may be a transitory disturbance of the visual fields and scintillating scotomæ.

Hypofunction of the anterior lobe of the pituitary gland has been suggested as a cause of retinitis pigmentosa. In thirty-five cases in which retinitis pigmentosa was present the condition has been reported as the Laurence-Biedl syndrome. I have seen this syndrome in a brother and sister, but the cases have not been reported. They had a Fröhlich type of obesity, deformity of the skull, retarded mental development and retinitis pigmentosa. Hypothyroidism is also usually present in such cases. The use of an extract of the anterior lobe of the pituitary gland in conjunction with thyroid has been suggested in the treatment of cretinism, because of the frequent finding of a small sella turcica in cretins.

The function of the posterior lobe of the pituitary gland is that of stimulating the sympathetic nervous system and the involuntary muscles. It influences the metabolism of sodium chloride, water and carbohydrates. Hyperfunction of this lobe produces hyperstimulation of the sympathetic nervous system, increases pigmentation and increases smooth muscle tone. The secretion of this lobe consists of a pressor principle which is more persistent than epinephrine and acts synergistically with it. It acts as an antidiuretic, as in diabetes insipidus.

Angioneurotic edema is sometimes associated with dysfunction of this lobe. Lenticular opacities associated with diabetes insipidus are sometimes found. Night blindness may result from hypofunction. Patients suffering from hypofunction of the posterior lobe have heavy superciliary ridges, shaggy eyebrows and thick lashes and frequently blepharitis. Mild ptosis may be a result of a hypofunction of this lobe.

In cases of combined dysfunction of the pituitary gland and gonads are found scleremia and one that may involve all ectodermal structures, such as the skin, conjunctiva, cornea and lens. Leber's disease (hereditary atrophy of the optic nerve) has been placed by some observers in the category of disturbances of the pituitary gland. Zentmyer noted definite changes in the sella turcica in a number of cases, and restoration of vision has been reported after the use of pituitary extract.

ADRENAL GLAND

The adrenal gland is essential to animal life. It is made up of two parts, the cortex and the medulla, each having a distinct action. The cortex is the part of the gland indispensable to life.

The cortex assists in regulating the concentration of sodium and of potassium in the body, controls pigmentation, stimulates the parasympathetic system and neutralizes toxins. It assists in the assimilation of vitamin C (cevitamic acid) and in that way should act favorably on cataract due to vitamin C deficiency. With deficiency of the cortex there are a loss of sodium and a retention of potassium, thereby causing an alteration of sodium-potassium ratio. This is followed by loss of water and loss of weight, which result in an increase in the nonprotein nitrogen and the urea content of the blood. Deficiency of the cortex results in a lowering of the blood sugar and glycogen stores and in an increased sensitivity to insulin. With marked deficiency of the adrenal cortex the skin becomes irregularly pigmented and darkened as a result of dehydration. There occur also diminution in oxygen consumption, muscular weakness, an increase in capillary permeability and, in extreme cases, circulatory collapse resembling histamine shock.

Hypofunction of the adrenal cortex may result in enophthalmos, and occasionally tumor or hyperplasia of the adrenal cortex is the cause of exophthalmos.

The medulla of the adrenal gland affects the pancreas, and apparently its secretion is antagonistic to insulin, thereby increasing the blood sugar, and it may cause sugar to appear in the urine. It stimulates the function of the thyroid gland, and their combined actions regulate the body temperature and metabolism. The secretion of the adrenal medulla contains pressor principle, its effect being more rapid but of shorter duration than the secretion of the posterior lobe of the pituitary gland. It is a definite stimulator of the sympathetic system and causes contraction of the smooth muscles, thereby affecting muscle tone and vasomotor control.

Myopia and, in some cases, glaucoma have been attributed by some to deficiency of the adrenal gland.

PANCREAS

The internal secretion of the pancreas controls carbohydrate metabolism. The external secretion controls digestion of fats and regulates the alkaline reserve.

In cases of hypo-insulinism there is an increase in the blood sugar, resulting in heightened susceptibility to pyogenic infections. By sudden lowering of the blood sugar there may be produced swelling of the lens with rapid refractive changes. Previously existing lenticular opacities may progress to maturity, or opacities may form in a previously clear lens. Uveitis may be caused by hypo-insulinism. There may be retinal hemorrhages or even massive hemorrhages into the vitreous as a result of changes in capillary permeability. However, hemorrhages

in the retina in these cases are most commonly due to vascular changes, the result of a prolonged increase in the blood sugar. Retinal lipemia may also be a result of hyperglycemia.

GONADS

The gonads are not self-regulating organs that control their own function. The anterior lobe of the pituitary gland is the main regulator of the activity of the sex glands. The adrenal cortex is also a gonadal stimulant. The thyroid gland, either through its interrelation with the pituitary gland and the adrenal cortex or by direct action on the gonads, also is a factor in gonadal stimulation, but this function is not well understood.

The gonads stimulate the sympathetic nervous system. As a result, patients with deficiency of gonadal hormones exhibit symptoms of hyperstimulation of the parasympathetic system, as manifested by vagotonia.

I have had a number of patients with hypogonadism with definite signs of hyperstimulation of the parasympathetic system or vagotonia. Most of the patients complained of blurred vision and had marked discomfort in the eye, with rather constant headaches and inability to use the eyes without discomfort. No abnormalities of the eyes could be found. Many of them manifested symptoms of sinus disease, including enlargement of the blindspot. Most of the patients had consulted several reliable oculists previously, with only temporary or no relief from the symptoms. Many of them were relieved by the administration of anterior pituitary extract, even castrated women responding to the treatment, and in one case the blindspot returned to normal in ten days. Of all the procedures I have used in the practice of ophthalmology, this is one of the therapeutic measures most appreciated by patients.

I have had a few male patients with hemorrhage in the retina and vitreous who gave positive reactions to tourniquet tests and whose condition did not respond to cevitamic acid, although no other cause could be found to account for the hemorrhages, but who immediately responded to whole ovarian substance and gave a negative reaction to the tourniquet test. After the administration of ovarian extract was discontinued, the hemorrhages returned and the tourniquet test again became positive. I diagnosed the condition of these patients as mild hemophilia, for which the treatment is administration of whole ovarian substance.

COMMENT

In the literature many ocular diseases have been attributed to endocrine disturbances. Glaucoma has frequently been mentioned as being of endocrine origin. There are so many types of glaucoma that it could

not be expected to be the result of a single endocrine syndrome. Cases have been reported in which the cause was thought to be hyperthyroidism, hypothyroidism, hyperpituitarism, hypopituitarism, allergy due to splenic deficiency, hypofunction of the adrenal cortex or gonadal deficiency. I have seen several patients in whom glaucoma was apparently due to endocrine dysfunction, but in none of them was it due to the deficiency of a single gland and in no two cases was the condition identical. I have used extract of adrenal cortex with a spectacular drop of intra-ocular tension after the first injection but with no results on subsequent injections. Likewise, I have used tissue extract with no definite results.

Some cataracts have been placed in the category of endocrine disturbances by a number of authors, and cataracts have been attributed to hypofunction of the pancreas, the parathyroid glands, the thyroid gland, the gonads and the adrenal cortex and to hyperfunction of both the anterior and the posterior lobe of the pituitary gland. I have seen patients with cataracts with associated dysfunction of all the aforementioned glands, but the one finding most frequently encountered in patients with cataract (both the congenital and the senile cortical type) is hypothyroidism, and in a great number of these cases there is also an associated hypogonadism.

Myopia is frequently ushered in by spasm of accommodation and can frequently be greatly diminished by the use of atropine. Physiologically, a spasm of accommodation should be due to hyperstimulation of the parasympathetic system or possibly to hypostimulation of the sympathetic system. On a physiologic basis, acquired myopia may possibly be due to endocrine disturbances, either hyperactivity of the adrenal cortex or the posterior lobe of the pituitary gland or hypoactivity of the anterior lobe of the pituitary gland, the adrenal medulla, the thyroid gland and the gonads.

Keratoconus has also been reported by several authors as being of endocrine origin. Some feel it to be due to deficiency of the thyroid gland and others consider it polyglandular in origin. Others are of the opinion that it is due to calcium deficiency, probably of parathyroid origin. The findings of these authors were not conclusive; however, I feel that there probably is a relation to some endocrine dysfunction not yet fully understood.

Some authors have associated trachoma with status thymolymphaticus, deficiency of the pituitary gland and adenoids. Their findings were not convincing.

Uveitis has been reported in association with endocrine disturbance, but except when it was due to diabetes the symptoms in most of the cases were only suggestive of an endocrine dysfunction.

Retinitis pigmentosa has been associated with dysfunction of most of the endocrine glands, but on a physiologic basis it is not likely to be associated primarily with any gland but the pituitary or the adrenal.

In fact, some authors have attempted to associate practically every clinical entity in ophthalmology with certain endocrine dysfunctions, but most of their contentions have little merit.

I do not wish to convey the impression that endocrine therapy is essential in all conditions that are enumerated as being endocrine in origin. It is well realized what the proper emotional environment will do to endocrine imbalance. Likewise, a vacation to the country will frequently readjust a marked endocrine imbalance. However, there are so many patients who cannot be sent to the country and whose environment cannot be adjusted that it becomes necessary to treat such patients as well as some dysfunctions that are primary in nature, and for these endocrine therapy is essential.

CONCLUSION

In conclusion, I wish to emphasize that the eye is the most fertile field for the study of endocrine disturbance and that it is the duty of every ophthalmologist to study the numerous manifestations of the various endocrine disturbances in order better to qualify as a consultant.

Many of the heretofore hopeless problems are being solved by studies of the endocrine system, and it is hoped that the day will come when many progressive conditions will be arrested by endocrine therapy.

A TENTATIVE INTERPRETATION OF THE FINDINGS OF THE PROLONGED OCCLUSION TEST ON AN EVOLUTIONARY BASIS

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SYRACUSE, N. Y.

No comprehensive and single hypothesis has been put forward to account for the phenomena grouped under the term heterophoria. Certain conditions underlying it have been mentioned, such as overdevelopment, faulty insertion or length of the muscle. The so-called declinations described by Stevens have also been considered responsible for some of these phenomena. Aniseikonia, too, has been mentioned as a possible cause, as has paresis or partial paralysis. The chief character of these anomalies is their variability.

These conditions may be said to be underlying anatomic states rather than causes. It is necessary to take a step farther back and ask what is the cause of these underlying states. It seems lacking in reason to attribute a variety of possibly causative conditions to phenomena which are fairly uniform in their manifestation, if one excludes the cases in which the etiologic factor is definitely paralysis or trauma.

When the subject is approached from an evolutionary standpoint, it is necessary to bear in mind some elementary principles. First, variation is a fundamental law of nature, all individuals, structures and functions varying within certain ill defined limits, all being equally normal but some more advantageous than others and therefore tending to survival.¹

Second, all structures and functions may be divided into two classes, the purposive and the nonpurposive. The purposive are those that have developed in response to the necessity for adaptation to changing environment and conditions of life and still perform certain definite and essential functions. The nonpurposive are those which serve no useful purpose and can be regarded as rudimentary or vestigial or as reversions to an earlier, originally purposive, type. Darwin has shown that these rudimentary or nonpurposive structures and functions are more liable to variation than those that remain purposive, the latter being

1. "The muscles are eminently variable. Mr. J. Wood has recorded the occurrence of 295 muscular variations in thirty-six subjects, and in another set of the same number no less than 558 variations" (Darwin, C.: *The Descent of Man*, New York, D. Appleton & Co., 1871).

subject to natural selection and therefore under control, whereas the former are uninfluenced by it.

According to Peter Chalmers Mitchell,² in the "Encyclopaedia Britannica":

The innumerable cases of structures which are rudimentary and apparently useless, in species the close allies of which possess well developed and functionally important homologous structures, are readily intelligible on the theory of evolution while it is hard to conceive their *raison d'être* on any other hypothesis.

It is necessary in the first place to call attention to the fact that at an early evolutionary stage there is no binocular vision, the eyes being placed laterally.

In his Bowman Lecture on "Arboreal Life and the Evolution of the Human Eye," Treacher Collins³ stated:

Animals, such as the terrestrial herbivorous mammals, who require panoramic vision, have their eyes set laterally in the head so as to obtain the largest circumferential effect of the combined monocular fields. Lindsay Johnson measured the divergence of the optical axes in a large number of representative animals, and constructed a diagram graphically showing how it varies in the different natural orders, families, genera and species. From this it seems that the most laterally placed eyes are met with among Rodentia, the Marsupialia and the Ungulata. The greatest divergence is in hares, whose optical axis in each eye measures 85° of divergence from the middle line. It seems probable that they, and some of the other rodents, have complete panoramic vision, i. e., are able to see in their circumference at one and the same time.

Among the Carnivora the smallest amount of divergence is in lions and cats, in which it is less than 10° in each eye. The Simiae and man alone among mammals have parallel optic axes.

This movement forward of the optical axes toward parallelism is clearly in the interests of binocular vision, and at the sacrifice of the range of simultaneous circumferential vision. As ontogeny is a condensed recapitulation of phylogeny, it is interesting to note that in the human embryo the optic vesicles when first formed are directly opposite to one another, from which position they gradually turn forward so that at the third month of fetal life the optic axes of each eye diverge 45° from the middle line; before birth they become parallel.

Thus the evolution of the race and the development of the individual concur in furnishing an explanation, at any rate for the lateral deviations, particularly exophoria. Orthophoria, or parallelism of the visual lines, is evidently the goal aimed at, but the attainment of it often falls more or less short, leaving exophoria of varying degrees, with or without hyperphoria (in about 78 per cent of cases, according to the prolonged occlusion test), esophoria, with or without hyperphoria

2. Mitchell, Peter Chalmers, cited in *Evolution*, in *Encyclopaedia Britannica*, ed. 11, London, Encyclopaedia Britannica Company, Ltd., 1910, vol. 10, p. 33.

3. Collins, E. Treacher: *Arboreal Life and the Evolution of the Human Eye*, Philadelphia, Lea & Febiger, 1922.

(in a small minority of cases—about 13 per cent). Pure esophoria occurs in only 2.2 per cent, pure hyperphoria in 5.5 per cent and orthophoria in only 3.4 per cent, this being no doubt due to the fact that cases are selected on the basis of a presumption of some muscle imbalance. This probably underestimates the prevalence of orthophoria in the community at large.

THE PHORIAS

The findings of the occlusion test in a large group of cases may be classified as follows:

1. Of 700 cases in which the occlusion test was limited to one eye, orthophoria was present in 3.4 per cent. Had the test been carried out on each eye, the percentage of orthophoria undoubtedly would have been less, judging from subsequent experience. This small percentage is perhaps due, as previously suggested, to the fact that the cases were selected on the presumption of the presence of muscle imbalance, and therefore the occurrence of orthophoria should be greater in the community at large.

2. Exophoria was present in 78 per cent of the 700 cases. As already indicated, this can be regarded as a rudimentary condition, the product of the failure of evolution and development to attain parallelism. It varied from 1 to 30 degrees, all normal variations. There was no evidence of primary or secondary deviation and consequently no suggestion of paresis.^{3a}

Maintenance of single vision in such cases is automatic, even when the degree of exophoria is high. Thus, in a patient with 30 degrees of exophoria, after occlusion diplopia never occurred, and the patient showed no ability to diverge at will. Occasionally, however, a patient is seen who can maintain fixation with one eye and diverge with the other, a distinct reversion to an earlier type of muscle balance. Thus in two cases reported by W. L. Phillips⁴ in 1906 it was possible for the patients to fix with both eyes and at the same time to turn either one out and back again to fixation while reading or to converge or diverge both simultaneously without diplopia.

3. Esophoria, or a convergent position, sometimes results when the advance from a divergent position toward parallelism is overdone. Esophoria, with or without hyperphoria, occurred in 13.2 per cent of

3a. In this article the word "paresis" is used in its strict sense of partial paralysis, and its nature is consequently shown by the presence of a primary and a secondary deviation, the latter being of higher degree than the former. The diagnosis of paresis must depend on the presence of this phenomenon.

4. Phillips, W. L.: A Man Having Ocular Movements Similar to Those Found Normally in Ungulates, *Am. Med.* **11**:428 (March) 1906.

the 700 cases. Pure esophoria occurred only in 2.2 per cent and consequently is a rare condition. Altogether, there were lateral deviations in 91.2 per cent of cases. There was no evidence of paresis in these cases.

These three conditions, exophoria, orthophoria and esophoria, constitute in the 700 cases a continuous series of variations of the position of rest in the horizontal plane from at least 30 degrees out to 16 degrees or more in.⁵

4. Hyperphoria is commonly described, without any attempt at differentiation, as a condition in which one eye has a tendency to deviate higher than the other. It may be divided into several types. It was present in 84 per cent of the cases, either alone or with lateral deviations.

(a) The first type is a definite one in which hyperphoria shows only when one eye is covered and not at all when the other eye is covered.

This is a matter of clinical importance. If occlusion is done on one eye only, the condition may be entirely missed. I recall a case of severe asthenopia seen some years ago in which I occluded one eye only. During occlusion the asthenopic symptoms disappeared entirely. At the end of the period of occlusion a perfect orthophoria was found, and on removal of the ground glass the symptoms returned. Subsequent experience makes me feel sure that if the other eye also had been occluded an explanation of the symptoms would have been found.

In this connection the case of Mr. K. R. S. is in point. He had severe neurasthenic symptoms, including sick headache for many years, without benefit from treatment. Occlusion of the left eye for eight days brought out no deviation, either vertical or lateral, as shown by chart 1. When the right eye was occluded, right hyperphoria (from 2 to 3 degrees) without lateral deviation developed. A partial prismatic correction of this deviation gave complete relief from symptoms.

Again, a patient who had been under my observation from early in life finally showed left hyperphoria of 4 degrees previous to occlusion, with the persistence of neurasthenic symptoms and headache in spite of refractive and muscle correction; after occlusion of the left eye for six days, 11 degrees of left hyperphoria (chart 2) was noted. When the right eye was occluded, the hyperphoria disappeared entirely or changed to a low degree of right hyperphoria. A fuller correction of the left hyperphoria gave great but not complete relief.

In a third case the patient had sick headache and showed 4 degrees of exophoria and a low degree of right hyperphoria at first (chart 3). When the left eye was occluded, 10 degrees of exophoria developed

5. The tropias were not included.

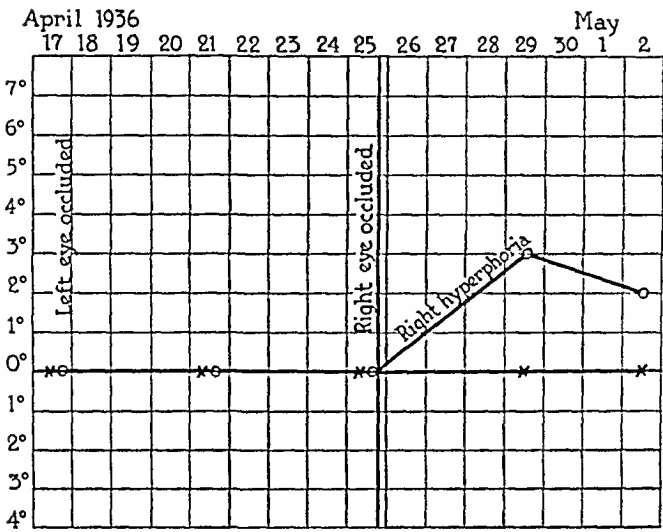


Chart 1.—Uncomplicated unilateral hyperphoria. In this and the following charts the cross (\times) indicates a lateral deviation—exophoria if the cross is above the zero line and esophoria if it is below it. The circle (o) indicates a vertical deviation—right hyperphoria if it is above the zero line and left hyperphoria if it is below it.

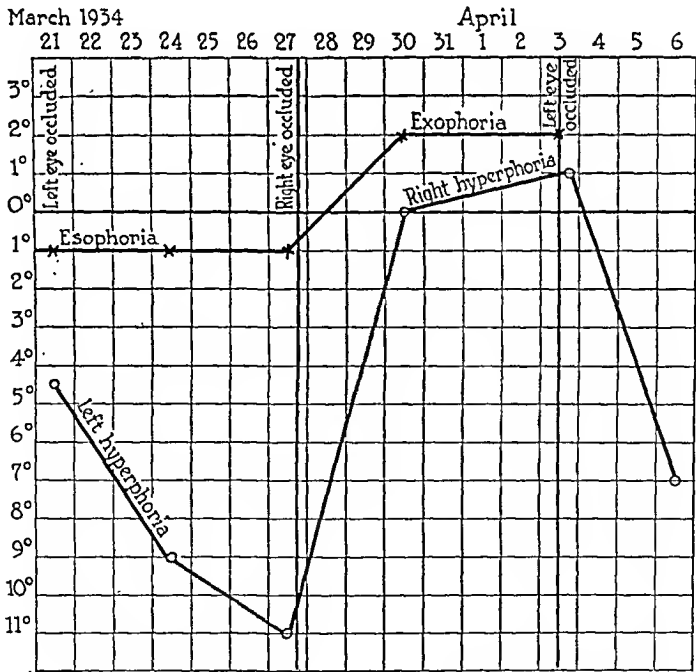


Chart 2.—Unilateral hyperphoria with low exophoria.

and no hyperphoria. When the right eye was occluded for five days, the exophoria increased to 13 degrees, and right hyperphoria of 8 degrees was present.

The conditions in these cases can be explained only by considering them reversions to an earlier evolutionary level in which the two eyes worked independently of one another, there being no interocular innervation; they are not consistent with the paretic theory, there being no evidence of primary or secondary deviation. On one side the elevator muscles balance the depressors in the horizontal plane. On the other side the plane in which they balance is above the horizon. In the prefusion period it was of no importance whether the vertical muscles

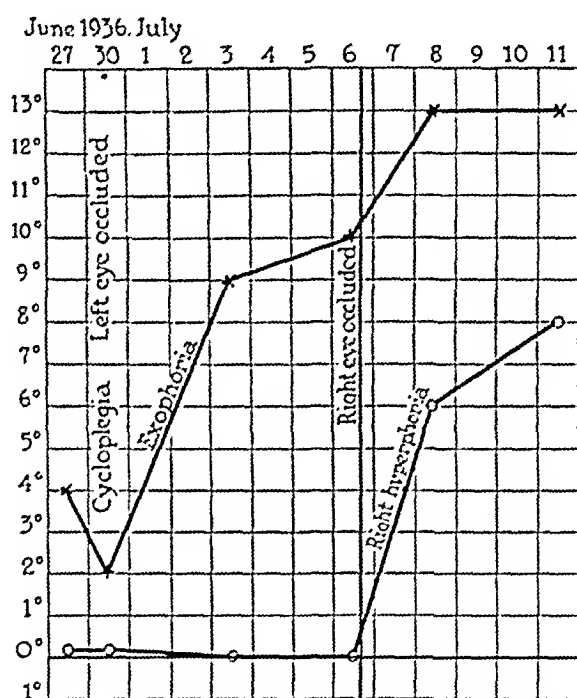


Chart 3.—Unilateral hyperphoria with high exophoria. Note the high degree of hyperphoria in these cases.

balanced in the same plane or not. Such differences may be regarded as normal variations. When occluded, the eye seeks its position of rest.

The alternative hypothesis, that some of these vertical deviations are due to paresis of one or more muscles, can be shown to be inapplicable in a large majority of the cases by a study of what seem to be primary and secondary deviations, whereas even in the cases which are consistent with the paretic theory the rudimentary theory affords just as satisfactory an explanation and is more in keeping with the usual.

(b) In the second type of hyperphoria a similar condition exists on each side, and each eye when covered deviates upward and comes

to rest above the horizontal plane. In other words, there is a *bilateral vertical deviation*, commonly known as double hyperphoria (anophoria). Hyperphoria is commonly greater on one side than on the other—anophoria plus hyperphoria. There is here certainly no evidence of any weakness of the muscles or of any primary or secondary deviation; consequently, the explanation must be some faulty relation, either in length or in insertion, of the vertically acting muscles. Each eye when released from fusion seeks its position of rest.

A good example of this type is shown in a case of progressive myopia (chart 4). At the preocclusion test orthophoria was present;

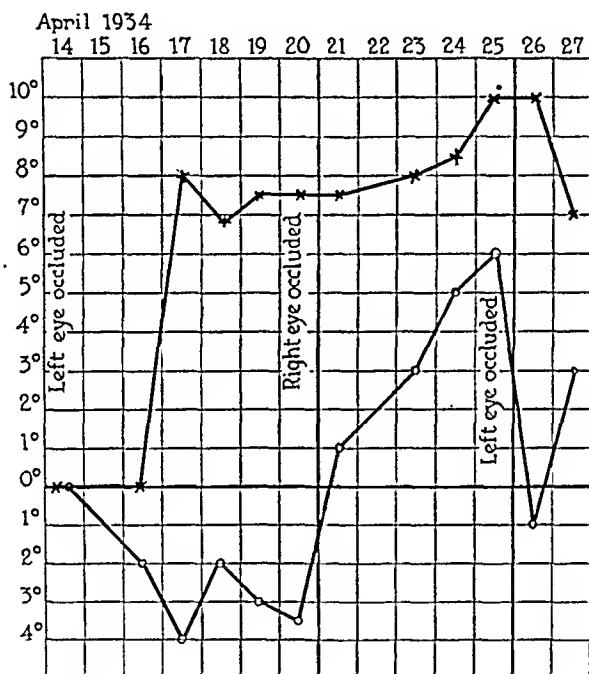


Chart 4.—Bilateral hyperphoria with exophoria (double hyperphoria).

with the left eye occluded there was left hyperphoria of 4 degrees, and with the right eye occluded, right hyperphoria of 6 degrees.

(c) In the third type the same kind of hyperphoria of moderate or low degree is found on each side, but it is usually greater on one side than on the other. In some cases, but not all, the condition suggests a primary and secondary deviation, but in all it is consistent with the variation theory of the position of rest—a nearer approach by evolution and development to orthophoria.

Thus, in the case of Mrs. H. A. V. (case 6 in the table), when the left eye was occluded, the right eye functioning, left hyperphoria of 3 degrees and exophoria of 9 degrees developed, the hyperphoria being greatest up to the left, indicating an insufficiency of the right inferior

oblique muscle. When the right eye was covered, the left functioning, the left hyperphoria decreased to 1 degree, the exophoria being 10 degrees. This might be an instance of primary and secondary deviation and therefore of paresis, but variation might equally well account for it. On the other hand, in the case of Mrs. J. H. T. (case 7 in the table), when the left eye was occluded, the right functioning, right hyperphoria of 0.5 degree and exophoria of 8 degrees developed. When the right eye was occluded, the left functioning, the right hyperphoria

Relation, or Lack of Relation, of the Underacting Muscle to the Kind of Deviation (Hyperphoria) Present

Case No.	Relatively Underacting Muscles*	Eye Occluded		Diagnosis
		Right	Left	
1.....	Right inferior rectus	4.5° right hyperphoria	3° right hyperphoria	Variation
2.....	Right superior oblique	0.5° right hyperphoria	2.5° right hyperphoria	Paresis or variation
3.....	Left inferior rectus	2° left hyperphoria	7° left hyperphoria	Variation
4.....	Right inferior oblique	1° left hyperphoria	6.5° left hyperphoria	Paresis or variation
5.....	Right inferior rectus	2.5° right hyperphoria	0.25° right hyperphoria	Variation
6.....	Right inferior oblique	1° left hyperphoria	3° left hyperphoria	Paresis or variation
7.....	Right inferior rectus	3° right hyperphoria	0.5° right hyperphoria	Variation
8.....	Right inferior rectus	3.5° right hyperphoria	0° hyperphoria	Variation
9.....	Right inferior rectus	3.5° right hyperphoria	2° right hyperphoria	Variation
10.....	Right inferior rectus	3° right hyperphoria	0° hyperphoria	Variation
11.....	Right inferior oblique	3.75° left hyperphoria	0° hyperphoria	Variation
12.....	Right inferior rectus	6° right hyperphoria	1° right hyperphoria	Variation
13.....	Right inferior oblique	3° left hyperphoria	0° hyperphoria	Variation

increased to 3 degrees and the exophoria to 10 degrees, the hyperphoria being greatest down and to the right. In other words, in spite of the insufficient muscle in the right eye, the vertical deviation was greatest when the left eye was functioning, a situation not consistent with the paretic theory.

Mrs. B. T. (case 8 in the table) showed right hyperphoria of 2 degrees at the preliminary examination. When the left eye was occluded the right hyperphoria changed finally to left hyperphoria of 1 degree. When the right eye was occluded, the left eye functioning, the right hyperphoria returned and finally measured 3.5 degrees. In this case the right hyperphoria was greatest down to the right. The right eye,

containing the paretic muscle, should have produced, when functioning, a greater deviation than that of the left eye. This was not the case. These two cases cannot be explained on the basis of paresis.

I have included in the accompanying table data on a series of unselected cases in which the deviation was of the same kind but of different degrees on the two sides and therefore possibly of a paretic nature. If not of a paretic nature, the only alternative would seem to be the natural chance anatomic variations. Even in those cases in which the deviations were of the primary and secondary types associated with the paretic theory, they might be equally well explained on the variation principle.

(*d*) In another type the relative position of rest of the two eyes is the same in kind and degree whichever eye is covered.

Thus, in the case of Mrs. E., when the left eye was covered 2 degrees of left hyperphoria developed. When the right eye was covered 2 degrees of right hypophoria was brought out. Or, to put it in other words, when the left eye was occluded the left eye turned up (left hyperphoria), and when the right eye was occluded the right eye turned down (right hypophoria).

(*e*) Still a fifth type exists, as in the following case. When the left eye was covered there was no hyperphoria. When the right was covered it deviated downward; in other words, right hypophoria developed. It would seem in this case that the term hypophoria is more suitable than hyperphoria.

In cases of this type it seems to make little difference in the kind and degree of lateral deviation whether the right or the left eye is covered. Thus, when the left eye of one patient was covered 4 degrees of left hyperphoria developed with 8 degrees of exophoria. When the right eye was covered right hyperphoria of 6 degrees and exophoria of 10 degrees developed; that is to say, with a difference of 10 degrees in the vertical position between the two eyes with the muscles relaxed there was only a variation of 2 degrees in the lateral deviation.

5. In addition to lateral and vertical deviations, the condition known as cyclophoria (rotation on the anteroposterior axis) requires some notice. This may be limited to one eye or may be greater in one eye than in the other and may vary from 0 to 10 degrees. This is observable in making the tests for hyperphoria with the Maddox rod and is more obvious after occlusion than before. It has in common with the other deviations a great variability in degree.

Two observations emerge from these groups of cases. First, hyperphorias are just about as common as exophorias—a fact not without significance. I am referring only, of course, to postocclusion findings.

Thus, of the first 700 cases a lateral deviation was found in 91 per cent (exophoria in 78 per cent and esophoria in 12 per cent) with or without vertical deviation. Hyperphoria, on the other hand, was present in 84 per cent, with or without lateral deviation. There seems to be no reason to seek different causes for the two groups (lateral and vertical).

PRISM ABDUCTION

In association with the phorias there are certain other phenomena which come up for consideration. What, for instance, is prism abduction? There are two possible departures in the horizontal plane from the parallel position the visual lines assume when the eyes are adjusted for infinity, that is, convergence and divergence. The reason for convergence is easily understood. It is a response to the need for binocular single vision and therefore depth perception for objects, especially at the near point. In other words, it is a definitely purposive phenomenon. On the other hand, divergence from parallelism is quite purposeless. Any useful purpose served by it is unthinkable. It may be, however, a vestige or rudiment of an earlier stage when the eyes could be used simultaneously in the interest of circumferential vision. As a matter of fact, it no longer exists in man under natural conditions and can be brought about only by placing prisms, base in, in front of the eyes. Prism abduction can therefore be regarded as a vestige of a function originally purposive and now no longer so. A case occasionally occurs in which the power of an active divergence still persists. This and prism abduction are evidences of the existence of a divergence center; so also with sursumduction and deorsumduction. They serve no useful purpose. In whatever position the head is placed single vision requires that the visual lines remain in that plane of the head in which the eyes converge for fixation of objects at different distances. If one visual line departs from that plane the slightest degree, confusion or diplopia must arise. These activities must be regarded as nonpurposive and therefore vestigial. Some animals representing an earlier evolutionary period, such as the chameleon, have the power of moving the visual lines into different planes.

Of this curious reptile, Gadow, the "Encyclopedia Britannica" stated:

The right and left eyes are incessantly moved separately from each other and literally in every direction, up and down, forwards and straight backwards, producing the most terrible squinting. [And yet] chameleons alone, of all reptiles, can focus their eyes on one spot, and conformably they alone possess a retinal macula centralis or spot of acutest binocular vision.

In keeping with their rudimentary nature, these phenomena (prism abduction and sursumduction) vary much in degree.

CONCLUSIONS

The phorias and ductions can all be accounted for on an evolutionary basis and on no other conceivable single hypothesis. The idea that many of the vertical deviations can be attributed to paresis is without sufficient justification. They occur in about the same frequency as, and often in association with, lateral deviations, and there seems to be no reason for assigning different causes to the two. Thus, in those cases in which the facts are consistent with the theory of paresis, they are equally well explained by assuming normal variation to be the cause.

The findings of the occlusion test furnish no reason for assuming the dependence of one form of deviation on another, except in some cases of manifest or pseudo-esophoria in which the effort to overcome hyperphoria calls on the third nerve for excessive activity, with resulting convergence. Manifest esophoria should always be looked on with suspicion.

The hypothesis put forward in this paper has the advantage of bringing into coherent relationship with one another a number of otherwise isolated phenomena.

Whether it proves to be valid or not, it certainly tends to clarify one's mind, give a definite point of departure and stimulate thought. For instance, if the condition described under the first type of hyperphoria is accepted as representing a prebinocular vision period and orthophoria is accepted as representing the culmination of the evolutionary process, as seems to be tacitly granted, what do the intermediate deviations stand for? Do they not represent a vast series of intermediate evolutionary periods? The theory also carries with it some suggestion as to the best method of dealing with the conditions found. For instance, in cases of the first type of hyperphoria, in which the deviation shows on one side only, it would seem rational to place the correcting prism before the hyperphoric eye. In cases in which there is the hyperphoria on one side and hypophoria of equal degree on the other, the prismatic correction should be divided equally between the two eyes. In cases in which the deviation is definitely of the hypophoric type, the correction should be placed before the hypophoric eye.

RETAINED INTRA-OCULAR FOREIGN BODIES

A CLINICAL STUDY, WITH A REVIEW OF THREE HUNDRED CASES

WILLIAM H. STOKES, M.D.

OMAHA

In this communication it is not proposed to enter into a lengthy discussion of the various problems encountered in the diagnosis and management of intra-ocular foreign bodies; the intention is rather to analyze the histories in a series of 300 cases of retained foreign bodies in the globe. A review of the recent literature was made in an effort to clarify and evaluate the present trends and more generally accepted methods of treatment. As the study proceeded, it became more and more evident that this topic is still in an amazing state of confusion and more or less resolves itself into a personal equation, the solution of which depends for the most part on the individual preference or whim of the author consulted.

One notes, however, the beginning of a more conservative approach; especially is this attitude in evidence among those oculists having the greatest experience. There is sufficient evidence accumulated over the years that the mere presence of a foreign body in the globe is no occasion for haste, excitement and ill advised removal. The analysis of this series of 300 cases supports that contention and has brought to light a number of interesting facts in sharp contrast to the prevailing opinion of ten or fifteen years ago.

No attempt is here made to formulate any set rule, nor does it appear seemly or profitable to the scope of this report to digress into theoretical discussions of the individual differences of opinion existing in this field, a debate that defeats its own purpose by repetition and one that can be settled only by time and recorded observation.

Once the diagnosis and definite localization of a foreign body within the eye have been made, the problem over which most of the division of opinion still exists is the question dealing with the route of extraction, whether anterior or posterior, and which of these is best suited with reference to the site of the foreign body. Obviously, no one route can be employed dogmatically to the exclusion of the other. My experi-

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ence has impressed on me another precept of equal importance and one that a number of years ago would have been denounced had any one had the temerity to advance it. All too frequently heroic methods have been employed to remove a foreign body on the assumption that its retention would sooner or later result in complete loss of vision or actual loss of the involved eye, with a probability of sympathetic ophthalmia occurring in the other. This attitude has in many cases actually precipitated a tragedy instead of averting one. It must therefore be kept in mind constantly that the question of which route of extraction to use may not always be the major consideration. One may be better justified under certain circumstances to allow the foreign body to remain in place. It is axiomatic that the removal of a foreign body from the interior of the globe does not insure saving either the eye or its vision. The prognosis in any event is always a serious one, and the oculist, though not always able to restore or save function, is under the moral restraint never to add insult to injury and aggravate an already trying condition by indulging in meddling interference.

ANALYSIS OF CASES

In reviewing the histories of these 300 cases it was interesting to note that subjective symptoms were not always in evidence or conclusive. In spite of the sensitivity of the cornea and conjunctiva, paradoxically, a number of patients were totally unaware that any accident had occurred, the entry of the foreign body having been quite painless. Four per cent of the patients gave no history of injury. In 3 cases the diagnosis was made many weeks later on the basis of an existing siderosis. One patient was treated elsewhere and referred to me because of an intractable iritis. The corneal microscope revealed a small flake of steel in the lens. In 2 cases in which the patient made no unusual complaints beyond that of so-called "eyestrain," the routine examination with the ophthalmoscope detected small scars in the cornea with corresponding minute holes in the iris, and on more detailed examination foreign bodies were found in the peripheral portion of the lens. In both instances vision was normal. Three other patients complained only of beginning and slight visual failure; all 3 had beginning traumatic cataracts from foreign body inclusion. Not one of these could recall any injury to the eye. One other patient had been treated for absolute glaucoma, but after enucleation of the eye a piece of steel was found lodged in the retina. I wish to emphasize, therefore, that while a careful inquiry into any possible trauma should never be omitted from the routine history, yet at the same time too much credence should not be placed on the patient's negative statement.

As to the methods used for diagnosis, little need be said here beyond mentioning the systematic use of the ophthalmoscope and the corneal microscope and the routine taking of roentgenograms in all cases in which an intra-ocular foreign body is suspected or even remotely considered to exist. I feel that the use of the magnet should never be resorted to as a diagnostic aid until all other methods have been exhausted and the roentgenographic report is inconclusive. Roentgenograms were obtained in all 300 cases, and it was possible to demonstrate and accurately localize the foreign body in 97.5 per cent of the cases. In the remaining 2.5 per cent, small foreign bodies were subsequently extracted with the magnet, the roentgenographic report being negative.

As to the incidence of penetrating bodies, I found that in this series the majority were noted in males engaged in the usual industrial occupations. Of the 300 patients, all except 6 were males, 60 per cent of whom were between 20 and 40 years of age. The right eye was injured in 133 patients, the left eye in 162 and both eyes simultaneously in 5.

As to the method of extraction, the anterior route was used in 140 cases and the posterior route in 39, leaving 121 cases in which other methods of treatment were employed. Of these 121 cases, there were 101 in which the foreign body was retained in some portion of the globe, the time element varying from one month to thirty-five years. In the cases in which the extraction was done with a magnet, the following principles were employed in the majority of instances: In those cases in which healing had not taken place, if the foreign body had entered through the cornea and passed through the lens into the vitreous chamber, the wound of entry still being open, and the fragment of steel was not too large, it was removed through the original site of entrance. If, on the other hand, the fragment was of such a size that its removal by the anterior route might produce further harm to the anterior structures of the eyeball, the foreign body was removed by a posterior scleral incision. If the foreign body had entered through the sclera, obviously its removal was effected through the sclera. In cases in which healing had taken place, the original wound having closed by solid union, the mode of extraction of the foreign body fell into one of two routes, either anterior or posterior, according to the location of the foreign body.

In an analysis of the 140 cases in which the anterior route was used it was found that a foreign body was removed from the anterior chamber in 20. Fifteen of the patients retained good vision, of 20/30 or better, and cataract developed in 3 (who were not operated on); of the remaining 2, who lost their vision permanently, 1 required enucleation because of panophthalmitis, and uveitis and phthisis bulbi developed in the other. There were 19 cases in which the foreign body was located

and removed from the iris. Fifteen of the patients retained good vision. Cataracts developed in 4, only 1 of whom was operated on. In 28 cases the foreign body was located and removed from the lens. Three of the patients retained good vision without glasses, although peripheral opacities were present. Cataracts developed in 21, 12 of whom were operated on, with subsequent good corrected vision. In the cases in which the foreign body was removed from the lens, only 3 of the patients had complete loss of vision. Severe uveitis developed in all 3 after removal of the foreign body.

Thus it will be noted that in the 67 cases in which the foreign body was removed by the anterior route from the anterior segment of the globe, 33 of the patients, or almost 50 per cent, retained good vision without correction, and the remainder were rendered industrially blind in the injured eye. Only 9 per cent lost their vision completely and permanently, owing to enucleation, severe uveitis or retinal detachment.

There were 73 cases in which the foreign body was located in the posterior segment of the globe, and its removal was effected by the anterior route. In 1 of these it was found in the ciliary region. A hemorrhage occurred in the vitreous in this case, with complete loss of light perception. In 66 of the 73 cases the foreign body was located in the vitreous. After extraction, 8 of the patients retained good vision without glasses; cataracts developed in 23, 5 of whom were operated on, with good corrected vision in all. In 34 cases vision was permanently lost, and in 1 the outcome was unknown. Retinal detachment was the cause of loss of vision in 16. Fourteen of the patients required enucleation because of panophthalmitis or uveitis. In 2, the vision was lost because of the failure of an operation for cataract. Glaucoma developed in 1 and retinitis proliferans in 1. There were 6 cases in which the foreign body was found and removed from the retina by the anterior route. Only 2 of the patients retained good vision, and cataract developed in 2, 1 of whom was successfully operated on.

To the casual reader this statistical survey may seem somewhat lengthy. However, in summarizing the foregoing figures it should be of interest to note that when the foreign body was located in the anterior segment of the globe and removed by the anterior route, good uncorrected vision was retained in 50 per cent of patients. Only 9 per cent lost the vision in the injured eye completely and permanently. But when the foreign body was removed by the anterior route from the posterior segment of the eye, good vision was retained in only 13 per cent of the patients, and in 50 per cent vision was entirely and permanently lost. It would seem obvious, therefore, that the anterior route of extraction for a foreign body located in the posterior segment is not the method of election.

This statement is sustained by analyzing the cases in which the foreign body was located in the posterior segment and was removed by the posterior route. There were 39 of these; in 7 the foreign body was in the ciliary region, in 27 it was in the vitreous and in 5 it was in the retina. Four of the patients in the first group retained good vision without glasses after removal of the foreign body. Total retinal detachment developed in 1. The results in 2 patients were complicated by cataracts, which were not operated on. Twelve, or 45 per cent, of the patients in the second group retained good vision after removal of the foreign body; cataract developed in 5, and 9, or 33 per cent, lost their vision because of detachment of the retina. There remains 1 case in which the outcome was unknown. Two of the patients in the third group retained excellent vision without glasses, but 3 lost sight in the injured eye because of retinal detachment, uveitis and macular degeneration, respectively. Thus it will be seen that when the posterior route was used for the extraction of a foreign body in the posterior segment, 49 per cent of the patients obtained good vision without glasses, and 33 per cent lost their vision entirely.

In a final summary as applied to these two routes of extraction, my figures indicate that 50 per cent of the patients with a foreign body located in the anterior segment of the globe and removed by the anterior route retained good vision without glasses, 9 per cent lost the vision in the injured eye permanently and the remainder were rendered industrially blind. Only 13 per cent of persons with a foreign body located in the posterior segment and removed by the anterior route obtained good uncorrected vision, and 50 per cent lost permanently the vision in the injured eye. Forty-nine per cent of the patients with a foreign body located in the posterior segment and removed by the posterior route obtained good vision, and 33 per cent lost the vision in the injured eye entirely. The inference is obvious. It may be stated that in none of the cases in which extraction was done by the posterior route were Walker pins used to prevent a possible occurrence of retinal detachment.

As stated in the earlier part of this report, there were 101 cases in this series of 300 in which the intra-ocular foreign body was not removed from the globe at the time of the accident but was retained within some portion of the eye, the time element varying from one month to thirty-five years. For purposes of completeness, a statistical survey of the histories was also made, the analysis of which has made me by conclusion less willing to accept certain popular tenets of the past in regard to the advisability of removing every foreign body whenever diagnosed.

Three patients retained copper in the anterior chamber for six months, two years and eight years, respectively. In all 3 the foreign body was removed with forceps. In 2 the vision remained good, but severe uveitis developed in the third after removal of the copper particle, and six years later the patient was able to count fingers only.

Six patients had retained the foreign body in the iris for from seven months to four years when first examined. In 1 patient a foreign body of either brass or copper was lodged in the iris for seven months. Vision was 20/30 and the patient refused to have the foreign body removed. In 4 other patients the foreign body was steel and was removed, with preservation of good vision. Siderosis, which was quite

TABLE 1.—*End-Results in Twenty-Six Cases in Which the Foreign Body Was Retained in the Vitreous for a Period of from One Month to Thirty-Five Years **

Case No.	Type of Foreign Body	Period Retained	End-Results
1	Steel (small)	1 mo.	Removed by anterior route; 2 mo. later, severe uveitis; enucleation
2	Copper	2 mo.	Retinal detachment; later, uveitis; enucleation
3	Steel	2½ mo.	Removed by posterior route; retinal detachment; no perception of light
4	Steel	2 mo.	Removed by anterior route; 2 yr. later, cataract; projection good
5	Lead	2 mo.	Uveitis; enucleation advised
6	Steel	3 mo.	Removal by anterior route followed by uveitis, sympathetic irritation; enucleation
7	Brass	6 mo.	Uveitis followed by detachment of the retina
8	Steel	11 mo.	Chronic uveitis; enucleation
9	Steel	1 yr.	Chronic uveitis; enucleation
10	Lead	1½ yr.	Retinal detachment; eye quiet
11	Steel	1½ yr.	Removed by anterior route; late, operation for cataract; detached retina
12	Steel	2 yr.	Removed by anterior route; detached retina
13	Steel	2 yr.	Uveitis; enucleation
14	Steel	2 yr.	Removed by anterior route; 5 yr. later, glaucoma; enucleation
15	Steel	2½ yr.	Removed by anterior route; 1 yr. later, glaucoma; trephine operation
16	Steel	2½ yr.	Glaucoma; enucleation advised
17	Steel	4 yr.	Retinal detachment
18	Steel	4½ yr.	Removal by posterior route followed by severe uveitis, sympathetic irritation; enucleation
19	Steel	7 yr.	Uveitis; enucleation
20	Steel	8 yr.	Uveitis; enucleation
21	Steel	9 yr.	Detached retina
22	Steel	10 yr.	Glaucoma; enucleation advised
23	Steel	10 yr.	Glaucoma; enucleation
24	Steel	16 yr.	Uveitis; enucleation
25	Steel	32 yr.	Cataract; no perception of light; no trouble
26	Steel	35 yr.	Uveitis; enucleation

* In summary, there was permanent loss of vision in 25 cases, in 1 of which operation for cataract might have been done. Enucleation was done in 18 cases and was advised in 3 others. Detachment of the retina developed in 8 cases and glaucoma in 3 others. The foreign body was removed by the anterior route in 7 cases, after retention of the steel for the period of from one month to two years, and by a scleral incision in 2 cases, with poor results in all.

extensive in all 4, disappeared completely a year after the extraction of the foreign body. One patient retained a flake of nonmagnetic metal in the iris for four years, and glaucoma developed, which was relieved by a trephining operation.

Of the 14 patients with a foreign body lodged in the lens, 4 lost their vision permanently. A piece of steel was removed from the lens of each of 2 patients two months after injury, and in each severe uveitis developed, which ended with complete blindness in the injured eyes. Glaucoma developed in 1 patient after retention of a piece of copper

in the lens for four years. The eye was enucleated. Retinal detachment developed in the other patient after an operation for cataract. In this

TABLE 2.—*End-Results in Forty-Nine Cases in Which the Foreign Body Was Retained Either in the Retina or in the Sclera for a Period of One Month to Twenty-Five Years**

Case No.	Type of Foreign Body	Period Retained	End-Results
1	Steel	1 mo.	Retinal detachment; results with magnet negative
2	Steel	2 mo.	Removed by anterior route; vision 20/20 2 mo. later
3	Steel	2 mo.	Magnet failed; removed by posterior route; severe iritis; enucleation
4	Copper	2 mo.	Copper in each eye; each eye blind
5	Steel	3 mo.	Removed by posterior route; 2 yr. later, vision 20/20
6	Steel	3 mo.	Uveitis; enucleation
7	Brass	3 mo.	Outcome unknown; no perception of light
8	Steel	6 mo.	Vision 20/20; removal by posterior route followed by severe uveitis; vision 2/200 6 mo. later
9	Steel	6 mo.	Removed by anterior route; 5 yr. later, vision 20/30
10	Steel	6 mo.	Nonmagnetic; observation for 2 yr.; vision 20/100
11	Steel	6 mo.	Removed by anterior route; detached retina
12	Steel	9 mo.	Extraction failed by posterior route; detached retina
13	Steel	1 yr.	Operation for cataract; retinal detachment
14	Steel	1 yr.	Vision 20/20; magnet not tried
15	Steel	1 yr.	Vision 20/50; magnet not tried
16	Steel	1 yr.	Operation for cataract; retinal detachment
17	Steel	1 yr.	Cataract; no operation; projection good
18	Steel	1 yr.	Cataract; no operation; projection good
19	Steel	1 yr.	Cataract; no operation; projection good
20	Steel	1 yr.	Vision 20/30; removed by posterior route; severe uveitis developed
21	Steel	2 yr.	Vision 20/15; magnet not tried
22	Steel	2 yr.	Removed by anterior route; severe uveitis; enucleation
23	Steel	2 yr.	Vision 20/40; magnet not tried
24	Steel	2 yr.	Vision 20/20; magnet not tried
25	Steel	2 yr.	Severe uveitis; enucleation
26	Steel	2 yr.	Operation for cataract; retinitis proliferans; vision 8/200
27	Steel	2 yr.	Severe uveitis; enucleation
28	Steel	2 yr.	Operation for cataract followed by severe uveitis and phthisis
29	Steel	3 yr.	Vision 20/40
30	Steel	3 yr.	Cataract; projection good; no operation
31	Steel	3 yr.	Glaucoma; enucleation
32	Steel	4 yr.	Vision of 20/40 for 3 yr.; retinal detachment
33	Steel	4 yr.	Retinal detachment
34	Steel	5 yr.	Vision 20/200; cataract
35	Steel	6 yr.	Operation for cataract; vision 20/70 with correction
36	Steel	8 yr.	Retinal detachment
37	Steel	8 yr.	Vision 20/30
38	Steel	9 yr.	Retinal detachment
39	Steel	9 yr.	Cataract; no operation; projection good
40	Steel	10 yr.	Vision 20/20
41	Steel	11 yr.	Cataract; good projection; no operation
42	Steel	12 yr.	Retinal detachment
43	Steel	12 yr.	Cataract; no operation; projection good
44	Steel	16 yr.	Vision 20/30
45	Steel	20 yr.	Vision of 20/70 for 12 yr.; finally iritis and glaucoma; enucleation
46	Steel	21 yr.	Glaucoma; trephine operation; no perception of light
47	Steel	15 yr.	Operation for cataract; vision 20/25 with correction
48	Brass	16 yr.	Retinal detachment
49	Steel	25 yr.	Retinal detachment

* In summary, there was permanent loss of vision in one eye in 26 cases, in only 7 of which it was due to enucleation. Retinal detachment occurred in 12 cases and glaucoma in 3. Good vision was retained in the injured eye in 13 cases (the foreign body being retained from two months to sixteen years), and in only 4 of these had the foreign body been removed. The foreign body was removed in only 7 of the 49 cases, in 3 with poor results. Cataract developed in 10 cases, in 2 of which operation was performed with good results.

case a nonmagnetic piece of metal was retained in the lens for a period of five years. Of the 7 patients in whom cataract developed, 5 were

operated on, and vision improved to 20/30 or better with glasses. Of course these eyes are considered industrially blind. Only 3 of the 14 patients maintained good uncorrected vision, the foreign body being located in the peripheral portion of the lens. One was a small splinter of glass which had been retained for four years.

Of the 3 cases in which the foreign body was lodged near the ciliary region, removal in 1 was done by the posterior route two months after the injury. Vision was 20/30 three years later. In the other 2 cases the foreign body was nonmagnetic. Severe uveitis developed in the eye of 1 patient two years after injury, and retinal detachment developed in the other patient eight years after the retention of the foreign body.

Table 1 shows the end-results in 26 cases in which the foreign body was located in the vitreous for a period of from one month to thirty-five years. Table 2 shows end-results in 49 cases in which the foreign body was retained either in the retina or in the sclera for from one month to twenty-five years.

In this series of 101 cases there was a total and permanent loss in vision in 60 eyes. Twenty-one of these eyes were enucleated, and enucleation of 3 others was advised. Good vision was maintained in 22 cases, in 9 of which the foreign body was removed—in 1 from the anterior chamber, in 3 from the iris, in 4 from the retina and in 1 from the ciliary region.

In the other 13 cases the foreign body was not removed but was retained in the following structures of the eyeball:

Location	Period of Retention	Vision
Iris	7 mo.	20/30
Lens	1 yr.	20/20
Lens	4 yr.	20/30
Lens	8 yr.	20/30
Retina	1 yr.	20/20
Retina	1 yr.	20/50
Retina	2 yr.	20/15
Retina	2 yr.	20/20
Retina	3 yr.	20/40
Retina	8 yr.	20/30
Retina	10 yr.	20/20
Retina	16 yr.	20/30

The retention of a foreign body in the vitreous chamber always gave rise to complications which led to ultimate destruction of vision.

In not a single case did the retention of a foreign body within the eye produce a sympathetic inflammation, but its removal in 2 instances did produce a sympathetic irritation.

A study of these 101 cases brings out one striking feature, perhaps the most significant of all, and that is the regrettable fact that in too many instances in which the eye and vision were good and in which the foreign body was removed, not only was the visual acuity reduced immediately but in much too high a number of cases complications of such serious nature developed that enucleation of the eye became necessary. I feel strongly that these complications were induced in quiescent eyes by nonindicated extraction of the foreign body.

Those who practice ophthalmic surgery must all be agreed that from a psychologic standpoint the enucleation of an eye is to a patient not only an operation of considerable magnitude but one approached by him with a trepidation amounting to terror, and justifiably so. For in many instances, especially in industry, the patient loses his ability to earn a living and is reduced to a state of economic dependency. All efforts, therefore, should be directed toward saving him from this calamity. Naturally many eyes are beyond salvation from the beginning, but I am impressed with the number of eyes in the present series for which enucleation became necessary many weeks or months after the original injury, which during that time were actually serviceable eyes.

Of the 300 cases, there were 67, or 22 per cent, in which enucleation was necessary. In 35 cases removal of the globe was necessary a few days after the accident as a result of panophthalmitis. The nature of the foreign body furnishes no clue as to cause of the infection. Possibly poor first aid care at the scene of the accident may explain this phenomena in part. I note, however, that in all except 1 of these cases the foreign body was lodged in the vitreous chamber. Possibly this is of some significance. In 22 of the 67 cases violent uveitis developed subsequent to the removal of the steel particle, and in the greater number of these cases the removal of the foreign body was attempted from months to years after the accident, during which time the patient had a good cosmetic eye, even though perhaps indifferent vision. In 7 cases enucleation was required, because of glaucoma. This, I feel, was unavoidable, as the eyes were blind and extremely painful. In 3 cases enucleation was required because of double perforations, to which was superimposed a panophthalmitis. Not a single enucleation was done because of sympathetic inflammation. This point I feel is certainly worth stressing. The conception that the retention of a foreign body within the eyeball will give rise to sympathetic ophthalmia seems to be founded on a false premise. The only case of this sort that occurred in the present series was that of a boy 12 years old, in whom sympathetic inflammation developed three months after a small flake of steel had been removed from the iris. Subsequently and with proper treatment he recovered vision of 20/20 in each eye.

A study of the cases in which a retinal detachment occurred brings to light some interesting facts.

In 41 cases in which retinal detachment occurred, the foreign body was located in the vitreous, and in 23 of these the removal of the steel was effected by the magnet, in 15 cases by the anterior route and in 8 by the posterior method. In the 18 other cases the metal which was retained in the vitreous was of the nonmagnetic variety.

In 9 cases in which retinal detachment occurred, the foreign body had its position in the retina. In 2 of these cases retinal detachment was noticed before the foreign body was removed by the magnet. In 1 instance a small piece of steel was retained in the retina for six months and gave no trouble. However, after removal of the foreign body there occurred severe uveitis followed by total detachment of the retina. In 1 other case the steel was removed by the anterior route, with resulting detachment. In the other 5 cases the metal was retained in the retina for periods of from one month to twenty-five years.

I feel that the most important causes of retinal detachment in this series of cases were an inflammatory retraction of the vitreous, producing bands of adhesions, retinal tears and postretinal hemorrhages and exudates.

In 17 cases (of the 300) the foreign body entered the cornea and perforated the sclera, causing a double perforation. In 3 of these panophthalmitis developed, and the eyes had to be enucleated. In the other 14, only 4 of the patients had useful vision, 20/50 or better, four months after the accident. The other 10 patients were observed over a period of from one to eight years, but all were rendered industrially blind in the injured eye either by cataract or by retinal detachment.

Of the cases in which the foreign bodies were of the nonmagnetic variety, copper was present in 13, brass in 5, lead in 5, glass in 2 and stone in 1. In analyzing these cases, it was found that a foreign body could be retained in the anterior chamber of the iris for a number of years with preservation of perfect vision. However, when it was retained in the vitreous the eye was lost in all cases, either by uveitis or by panophthalmitis. In all 5 cases in which the intra-ocular foreign body was brass enucleation was necessary. The same applied to lead, glass and stone, when the particle was in the vitreous. No attempt was made in this series to remove nonmagnetic foreign bodies if they were located in the posterior segment. It seems apparent, therefore, when one is dealing with nonmagnetic foreign bodies, that one located in the anterior segment may be tolerated for over a period of years without producing harm, but one lodged in the vitreous invariably produces disorganization of the structures of the globe. Even though there may have been little irritation for a considerable period, iridocyclitis and

loss of the eye were the final results in the cases under consideration. Foreign bodies lodged in the retina or in the retina and sclera were tolerated about as well as those lodged in the anterior segment of the globe.

Before concluding, a word seems in order apropos of the treatment after extraction. The postoperative care is of utmost importance. It is difficult to impress the necessity of this on the average laborer. A man who otherwise feels well finds it hard to reconcile himself to the confinement of absolute rest in bed for a period of from ten to fourteen days after the removal of a small piece of steel from the posterior segment of his eye. He not only regrets the loss of time at work but is likely to consider the entire procedure a trivial one. However, experience has taught that such precautions are well worth while and should be insisted on in every case, no matter how simple the operation of extraction might have been. More recently I have used electro-coagulating pins for all extractions by the posterior route. Three or four pins are placed into the sclera as near to the foreign body as possible, the same technic being used as in the operation for retinal detachment. These pins are placed in position before the sclera is opened and the foreign body removed. I believe that detachment of the retina is reduced to a minimum by this precautionary measure.

CONCLUSIONS

This study has brought my attention to the following points:

While an inquiry into the history of an accident should always be made of all patients coming to the oculist for examination, a negative subjective history is no criterion that none occurred.

It is of paramount importance to have accurate localization before extraction is attempted, and this can be obtained in all but a few exceptional cases by roentgenographic studies.

Rarely should the magnet be used for the mere detection of a foreign body.

A foreign body located in the anterior segment is best removed by the anterior route, and one in the posterior segment, through the scleral route. Electrocoagulating pins should be used in all cases in which extraction is done by the posterior route. It is best to remove a foreign body from the interior of the eye in cases of recent injury.

The view that the retention of a foreign body in one eye will cause a sympathetic inflammation in the other eye is not sustained by my observations. On the contrary, I have found that sympathetic irritation developed only in cases in which ill advised efforts at removal were utilized.

Preservation of useful vision or of the eyeball is possible perhaps for the entire lifetime of the patient in spite of the retention of a foreign

body in the posterior segment of the globe. One may assume that such a patient could not have fared better had intervention been adopted.

The knowledge that a foreign body within the eye may be tolerated for prolonged periods of time is worthy of consideration when one is deciding on the management of such cases, and conservative treatment is more often indicated than recommended by the majority of writers on the subject. However, the patient must be under the observation and care of a competent oculist for a period of years.

TECHNIC OF GONIOTOMY

OTTO BARKAN, M.D.

SAN FRANCISCO

Goniotomy, or the opening of Schlemm's canal under direct vision, is an operation for the relief of that form of chronic glaucoma which is characterized by an open angle and normal depth of the anterior chamber.

The success of the operation¹ depends on two essential factors: (1) the proper selection of suitable cases by a preoperative biomicroscopic examination of the angle of the anterior chamber and (2) the use of a specially made contact glass, the prismatic action of which provides a magnified picture of the inside of the angle of the anterior chamber, so that the surgeon is able under direct vision to guide his knife from the temporal limbus across the anterior chamber until it strikes the trabeculum on the opposite side. A similar approach to the angle was used by De Vincentiis in 1892, but his procedure was a blind one, since it was impossible to see where the knife was going. Moreover, in the absence of a biomicroscopic (gonioscopic) method, it was impossible to determine which cases were suitable. The operation was later abandoned.

PRELIMINARY PROCEDURES

The surgical contact glass (fig. 1)² should be tried on the patient's eye previous to the day of operation in order to insure its adaptability to the individual case. The standard model will be found to be satisfactory for most cases, but occasionally an exceptionally narrow palpebral fissure demands the use of a smaller model. The lids are separated with a speculum or by means of lid sutures in cases in which the palpebral fissure is narrow. Canthotomy should be avoided, for a trace of blood in the conjunctival sac is likely to disturb visibility by mingling with the fluid between the cornea and the contact glass. As direct vision is the essence of this procedure, the thought of maintaining visibility must always remain foremost in the surgeon's mind. Everything should be ready before local anesthesia with pontocaine (paranormobutylaminobenzoyldimethylaminoethanol) hydrochloride is started. Anesthesia should not be prolonged beyond the few minutes that are

1. Barkan, Otto: A New Operation for Chronic Glaucoma, *Tr. Sect. Ophth., A. M. A.*, 1936, p. 244; A New Operation for Chronic Glaucoma: Restoration of Physiological Function by Opening Schlemm's Canal Under Direct Magnified Vision, *Am. J. Ophth.* **19**:951-966 (Nov.) 1936.

2. The surgical contact glass is now available from Carl Zeiss, Inc., New York.

necessary to induce it. Once the glass is applied, the steps of the operation should follow in rapid succession in order to avoid a disturbance of visibility due to haze of the corneal epithelium, the formation of folds in Descemet's membrane (which may occur in eyes with low tension after prolonged contact with the glass) or the entrance of air bubbles or blood between the contact glass and the cornea.

TECHNIC OF OPERATION

1. The pupil should be miotic, the eye having been well treated with physostigmine before operation.

2. Local preparation of the eye is the same as for any intra-ocular operation, except that the lashes of only the outer third of the lids need be clipped. Ointment should not be used, in order to avoid the formation of an oily film on the glass.

3. Akinesis is secured in the usual way.



Fig. 1.—Surgical contact glass.

4. The height of the operating table and of the eye of the patient is so adjusted that the surgeon, who stands at the side of the patient's head, may conveniently transfer his gaze from the limbus to above the temporal edge of the contact glass and to the anterior chamber by means of slight movement of his head or body. If the surgeon prefers to sit on a stool, its height must be adjusted relative to the eye of the patient so that the surgeon may transfer his gaze by means of a slight movement of his head.

5. Local anesthesia is obtained by means of instillation of drops of 1 per cent pontocaine hydrochloride. An applicator saturated with 1 per cent pontocaine hydrochloride may advantageously be held on the nasal limbus for five seconds. A drop of 1:1,000 solution of epinephrine given with the last drop of pontocaine hydrochloride increases the corneal luster.

6. Immediately after this last drop, everything being in readiness, the eye is fixed with a forceps, and the surgical contact glass is applied in the following manner:

In the case of the right eye, both the patient's face and his gaze are rotated to his left. In the case of the left eye, the direction is

reversed. After the conjunctival sac is freed of mucus or débris that may disturb the visibility, the surgeon grasps the limbus at 10 o'clock with a small, Elschmig forceps, with a lock, held in his left hand. The forceps is locked and is permitted to hang from the limbus. It will be found that fixation is best done before rather than after the application of the glass. If, however, the surgeon prefers to apply the glass first, in order to prevent the entrance of air through dimpling of the sclera he must exert a little extra pressure on the glass with an applicator held in his right hand while the left hand grasps the limbus with the forceps. After the surgical contact glass is placed on the eye, physiologic solution of sodium chloride is injected under the temporal edges of the glass by means of a 1 cc. Luer syringe with a small curved cannula.

With the head still maintained in this position, the patient is directed to rotate his gaze slowly from the left straight upward. The eye with the contact glass on it is now in a position of abduction relative to the head and looks straight at the ceiling. The assistant, who stands behind

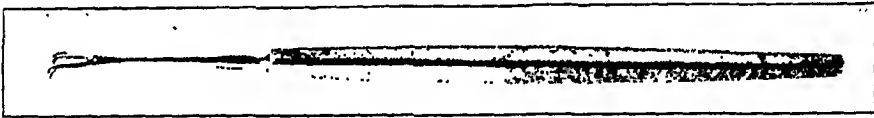


Fig. 2.—A bident.

the head, keeps the glass in position by means of a double-pronged probe, a bident (fig. 2), which is held in the right hand without exerting undue pressure and in such a manner as to leave a crescent of the temporal limbus exposed. Such pressure as there is must be in *the direction of the optic axis of the globe* in order to avoid the entrance of air under the glass. As soon as fixation is established and the glass applied, care must be taken to avoid pressure with the forceps. Traction rather than pressure should be exerted. The surgeon then (1) dries the temporal limbus with the tip of an applicator, (2) applies a solution of iodine at the intended point of puncture with an applicator and (3) punctures at this point (just scleral to the corneoscleral border) with the goniotomy knife. A second assistant or nurse has meanwhile guided the narrow beam of a hand lamp³ from across the bridge of the patient's nose to transilluminate the nasal portion of the limbus and the corresponding region of the angle of the anterior chamber. The surgeon, who stands in a comfortable position at the side of the patient's head, the table having been previously adjusted to the proper height, guides

3. An improved focal illuminating lamp designed for this purpose will be available in the near future. The goniotomy knife can be obtained from V. Mueller & Co., Chicago.

the knife (fig. 3) ⁴ across the chamber and into the angle between its lower and its nasal third in the right eye and between its upper and its nasal third in the left eye by direct vision through the glass. When the blade reaches the magnified angle, its point is inserted into that portion of the trabeculum which covers Schlemm's canal and the incision is continued counterclockwise for several millimeters along this line (about one fourth of the circumference). For the right eye the surgeon stands to the right of and behind the patient's head; for the left eye, he stands at the patient's left shoulder. If the incision appears insufficient either in extent or in depth, the knife may be rotated on its axis and the incision repeated in the reverse direction. The knife is then quickly removed without loss of aqueous, care being taken to avoid enlarging the puncture

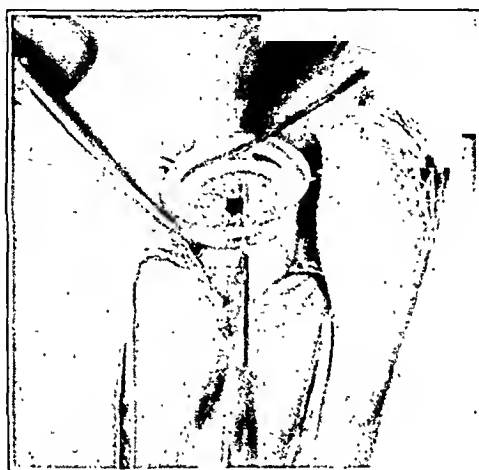


Fig. 3.—Goniotomy, showing the knife crossing the anterior chamber.

wound at the limbus by pressing slightly against the back of the blade during removal. There may be a slight amount of bleeding into the anterior chamber from the intrascleral plexus along the line of incision, but this is absorbed within a few hours.

In traversing the chamber, the knife must always cross the optic axis. The diameter of the arc that it describes after the trabeculum is engaged will then be greater than the diameter of the circumference of the limbus, and thus the point of the knife remains engaged during the incision. If the knife does not cross the optic axis, the opposite holds true; in describing a smaller arc than that of the limbus, the point of the knife soon becomes disengaged, and too small an incision is made.

Owing apparently to the varying topographic relations of the angle and of Schlemm's canal, one cannot always be certain of opening the canal. That this may be accomplished with a fair degree of certainty and

4. Figure 3 illustrates an earlier model of the contact glass and probe than is now being used.

exactitude is shown by the results of postoperative biomicroscopic examination, which usually shows a single straight dehiscant slit of the trabeculum over Schlemm's canal associated with normalization of intra-ocular pressure. What appears to be the glistening white inner lining of the outer wall of Schlemm's canal is visible through this longitudinal bisection of its inner wall. The sclerocorneal trabeculum may be either bisected or torn off, the operation constituting what may be called a trabeculotomy or trabeculectomy, respectively.

RELATION OF AMOUNT OF REDUCTION OF INCREASED INTRA-OCULAR PRESSURE TO EXTENT OF OPENING OF SCHLEMM'S CANAL

It is interesting to compare the great initial drop of intra-ocular pressure in one case, for instance from 120 to 42 (McLean), as the result of an extremely small opening of Schlemm's canal with the relatively small drop of pressure, from 50 to 22 (McLean), as the result of an extensive incision (from 3:30 to 7 o'clock on the limbus) in another case. This suggests that the degree of increase of intra-ocular pressure in "type 1 glaucoma" as in other varieties of glaucoma is largely a function of the vasomotor reflex of the particular patient and that it is in less direct relationship to the amount of mechanical block. As a matter of fact, in the first of the aforementioned cases pressure gradually returned to 70 in the course of eight months, showing that although the opening was sufficient to permit of temporary compensation via the vasomotor factor, it was insufficient to reestablish normal pressure permanently through an adequate outflow of intra-ocular fluid, as did the larger incision in the second case. Judging by this example and the experiences in other cases, it would appear that an incision to the extent of at least one fourth of the circumference is required for a permanently successful outcome. An incision that is too small is only partially effective, and it may also be that it is more likely to close in time, although one cannot be certain of this at present.

MAGNIFICATION

Magnification is obtained by wearing a binocular head loupe of desired strength. A 5 diopter head loupe when combined with the refractive power of the contact lens and the eye gives a total linear magnification of about 6 times. In selected cases in which higher magnification is desired the operation may be performed with a corneal microscope attached to the surgeon's head by means of a helmet. With this microsurgical technic, a magnification of 20 times may be obtained.⁵

5. Barkan, Otto: *Micro-Surgery in Chronic Simple Glaucoma*, California & West. Med. 48:10-12 (Jan.) 1938.

ILLUMINATION

An assistant or nurse who stands on the opposite side of the patient's head directs the spotlight of a hand lamp at the nasal limbus, transilluminating it. While the incision is being made, the spotlight is directed so as to follow the point of the knife, which is visible to the assistant through the sclera as it moves along slitting the trabeculum. The surgeon can further direct the movement of the light by word of mouth. A second assistant or nurse stands beside the first one toward the foot of the patient and directs the light from a second lamp onto the eye for purposes of general illumination. This light can be removed or used at will during the procedure. It also serves as a reserve in case the first light should become obscured or get out of order. Thus constant illumination of the angle of the chamber is assured during the operation.

POSTOPERATIVE CARE

A patient is customarily hospitalized for two or three days, both eyes being occluded for the first twenty-four hours. The pupil of the eye on which operation was performed should be kept miotic with physostigmine for three weeks after the operation in order to prevent the root of the iris from being washed against or becoming adherent to the incision.

INDICATIONS

As has been suggested in a previous article,⁶ this operation is indicated for a certain type of condition only, namely, that type which according to my classification constitutes a pathologic anatomic entity, which I have called type 1 chronic glaucoma. This is characterized by an open angle and normal depth of the anterior chamber. It includes the clinical condition commonly known as chronic simple or noncongestive glaucoma, but in addition, covers all forms in which there are a deep anterior chamber and an open angle, even though they are congested. It does not include the forms in which there are a shallow chamber and a narrow angle and the glaucoma runs a noncongestive course for many years, appearing clinically similar to and often being confused with typical chronic simple glaucoma. The procedure is especially gratifying when used as an early operation. It will be found effective also in certain cases of secondary glaucoma in which the increased intra-ocular pressure is likewise due to a block of the sclerocorneal trabeculum. It is less effective and may even be contraindicated in certain rare instances of type 1 glaucoma in which there are a high degree of vasomotor instability and a tendency toward vascular decompensation. Preliminary paracentesis may be indicated in such cases, or it may be better to employ primarily cyclodialysis or trephination.

6. Barkan, Otto: Recent Advances in the Surgery of Chronic Glaucoma, *Tr. Am. Acad. Ophth.* **41**:469-488, 1936; *Am. J. Ophth.* **20**:1237-1245, 1937.

PROVISIONAL SURVEY OF RESULTS

Results in the twenty-five eyes operated on to date will be published in detail and elaborated on later. Provisionally, it can be stated at this time that in my experience the tension in those cases in which the trabeculum has been incised over a sufficient extent of its circumference, namely one fourth, has been normalized to date, the longest period of observation being two years. In other cases in which the incision was insufficient in extent the tension has been normalized, but only with the additional use of miotics. The tension in these cases, however, was improved by the operation, since miotics had been insufficient to normalize it before operation. Reoperation in those cases in which the trabeculum was missed or the canal was not opened has not shown any effect on the intra-ocular pressure, and a further operation will be necessary. In this connection it may be noted that no damage is ever done by goniotomy and that it in no way militates against the subsequent use of other intra-ocular operations should they be desired or indicated. It seems likely that with the present improved technic a high percentage of completely successful results will be maintained and that reoperation will be required in only a few cases in which the results were incomplete.

CONCLUSION

The essence of goniotomy is its complete safety. No complications or injurious sequelae have been observed in any case in which the operation was performed to date. This makes it especially adapted to early operation, which is the greatest need in the surgical treatment of glaucoma today.

490 Post Street.

DOUBLE PERFORATIONS OF THE EYEBALL

A CLASSIFICATION

N. I. MEDVEDEF

STALINO, DONBASS, U. S. S. R.

In modern industry, in which instruments and tools of great power are in use, piercing lesions of the eyeball frequently occur. After the foreign body has passed through the wall of the eye in its anterior or anterolateral section, it still retains sufficient kinetic energy to enter the orbital cavity on its way through the vitreous and the posterior wall of the eyeball.

In rare instances such a foreign body may perforate the osseous wall of the orbit and enter the brain.

Perforating lesions of the eye or so-called double perforations of the eyeball (Hirschberg) differ considerably from the usual piercing injuries in their clinical evolution.

There is, however, practically no classification of these lesions in common use. In the articles and descriptions dealing with individual cases the authors have given arbitrary explanations of these facts. Some have accepted the indications of Hirschberg and regard as perforating lesions only those in which the foreign body is lying freely in the orbit, without being attached to the eye. Others, who form the majority, consider as cases of such lesions all those in which the foreign body has pierced the posterior, as well as the anterior, wall of the eye, whatever final localization the foreign body may have.

This divergency of opinions hinders the analysis of the material that is being accumulated and consequently detains the progress of knowledge of this question. It is a well known fact that reaction of the orbit is the first and foremost symptom of recent double perforation.

Forsmark, Rübel and Wagenmann have already noted the symptoms of recent double perforation, which have, however, not yet received sufficient consideration.

During the period between 1929 and May 1937 thirty-seven patients with double perforation of the eyeball have been treated in the Central Ukrainian Institute of Ophthalmology in Kharkov and at the ophthalmic clinic of the Donetz Mining District (Donbass). Among these patients, nineteen came for treatment within the first ten days after the accident. An analysis of the histories of disease shows that in one

case only signs of a lesion of the retrobulbar tissues were lacking. In this unique instance the injuring splinter (a fragment) was small (measuring less than 1 by 3 mm.) and was located in the orbit near the posterior wall of the eyeball. The other eighteen patients had well marked orbital symptoms.

Edema of the eyelids and chemosis of the conjunctiva of the eyeball were the symptoms which most frequently accompanied retrobulbar localization of the injuring object. Fifteen of the nineteen patients presented various degrees of reactive phenomena in the orbit. In these instances there was no infectious process in the eye itself that could have caused the reactive edema.

Exophthalmos and impairment of the movements of the eyeball were noted in ten patients.

TABLE 1.—*Distribution of Cases of Double Perforation of the Eyeball According to Localization of Foreign Body*

(Patient entered the clinic within 10 days after the accident.)							
Localization of Foreign Body	Orbital Symptoms						Total Number of Cases
	Cases in Which Fragment Measured Over 5 Mm. in One Dimension			Cases in Which Fragment Measured Less Than 5 Mm. in Every Dimension			
	Consid- erable or Intense	Moderate or Slight	Absent	Consid- erable or Intense	Moderate or Slight	Absent	
1. Retrobulbar, outside eyeball...	5	1	..	3	1	..	10
2. Retrobulbar, connected with posterior portion of channel of wound.....	..	2	..	..	1	1	4
3. Fixed in wound of exit.....	2	3	..	..	..	..	5
Total.....	7	6	..	3	2	1	19

In cases of recent perforating lesion of the eyeball there often are hemorrhages underneath the skin of the eyelids and under the conjunctiva of the eyeball. Such hemorrhages, the localization of which is in no direct way connected with the anterior portion of the channel of the injuring body, were found in eight instances, i. e., in nearly half of the cases.

The present article is not intended to give a complete statement of the diagnosis, evolution and prognosis of perforating lesions of the eyeball, which I have, moreover, discussed fully in another communication.

I deem it necessary only to note the chief specific features in the semeiotics of these lesions which do not find sufficient consideration in the clinic.

I have divided all the cases of recent double perforation of the eyeball into three groups (table 1). The findings in the numerous

cases observed by my associates and me thus demonstrate that fragments which enter the orbit through the eye nearly always cause orbital symptoms.

An analysis of our material shows that orbital symptoms do not appear only in those cases of double perforation of the eyeball in which the foreign body is freely located in the orbital tissue (Hirschberg). They are likewise well marked in cases in which the foreign body is fixed in the posterior portion of the channel of the wound so that only part of it protrudes into the orbit, while the other part remains in the eye; the same is true in the case of a foreign body which has perforated the posterior wall of the eye and is localized in the orbit, where it remains in connection with the wound of exit in the sclerotic. No doubt foreign bodies in such a location (belonging to the second and third groups) have the properties of intra-ocular foreign bodies.

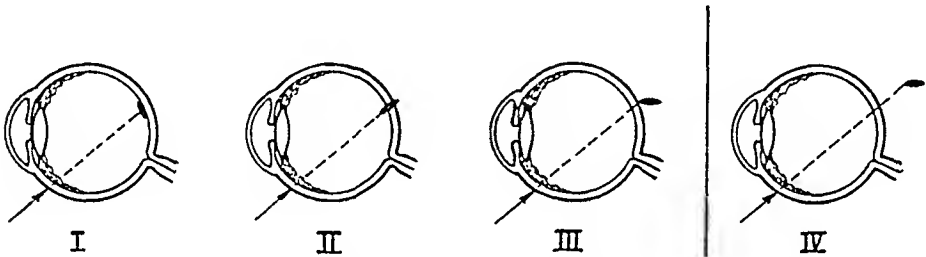


Fig. 1.—I, II and III illustrate perforating trauma of the eyeball, with lesion of the posterior wall (intra-ocular foreign body). IV illustrates double perforating lesion (intra-orbital foreign body).

It is also evident that when their size is sufficient they act as retrobulbar fragments would act. In view of the fact that, in consequence of the greater resistance they encounter, foreign bodies sooner lose the energy and velocity of their movement, one can easily comprehend why such large fragments are more often fixed in the posterior wall of the eyeball or remain in the neighborhood of the posterior wall, being connected with the latter. This is demonstrated in figure 1.

According to Hirschberg, one must regard severe lesions caused by a foreign body and followed by injury of the posterior wall as presented in figure 1.

Wagenmann agreed with Hirschberg in thinking that for the prognosis of further evolution and for the purpose of therapy it is most important to know whether there is complete double perforation, with the foreign body outside the eyeball, or whether the foreign body is partially fixed inside the eye.

Our material demonstrated clearly enough that fragments shown by their localization to cause lesions belonging to the second group illus-

trated in figure 1, i. e., those that are fixed in the posterior wall, and fragments that cause lesions belonging to the third group illustrated in figure 1 produced well marked orbital symptoms.

It is evident that injuries caused by foreign bodies with such a localization may not be considered as belonging to the group of those caused by the usual intra-ocular fragments.

I think it right to regard as cases of double perforation all those in which the object penetrating into the eye has caused a second wound while perforating the posterior wall of the eye.

Taking into account the ultimate evolution, depending on the position of the foreign body, I think it correct to distinguish three groups of perforating lesions of the eyeball (fig. 2).

Among cases of the first group—*perforatio bulbi duplex completa*—I place instances of double perforation of the eyeball in which the injuring object is found outside the eyeball, lying freely in the orbit.

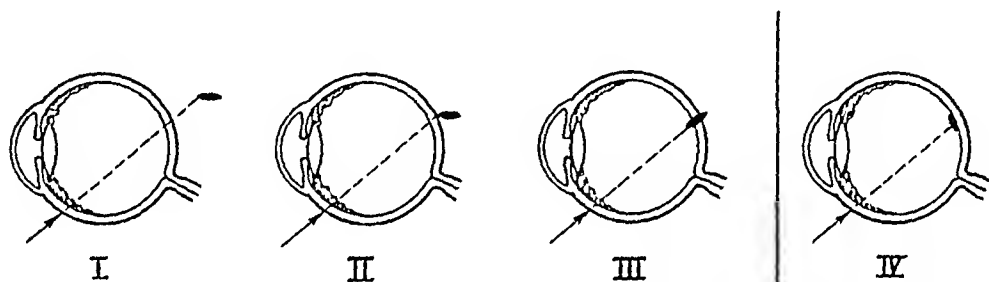


Fig. 2.—*I, II and III* illustrate double perforating lesion through the eyeball. In *I* the intra-orbital splinter is outside the eyeball. In *II* the splinter is outside the eyeball but connected with the posterior course of the lesion. In *III* the splinter is jammed between the borders of the posterior course of the lesion. *IV* illustrates perforation of the eyeball by an intra-ocular foreign body, with no lesion through the posterior wall.

TABLE 2.—*Distribution of Cases of Double Perforation of the Eyeball According to End-Results*

Group	Total Number of Cases	Acuity of Vision at Time of Dismissal from Clinic				Enuclea- tion
		1.0 — 0.5	0.5 — 0.1	0.1 —	0	
I.....	19	3	3	5	2	6
II.....	9	..	..	4	..	5
III.....	9	..	..	3	2	4
Total.....	37	3	3	12	4	15

Among cases of the second group—*perforatio bulbi duplex fere completa*—belong instances of double perforation in which the foreign body localized outside the eyeball but in connection with the wound of exit.

Among cases of the third group—*perforatio bulbi duplex cum inelatione*—belong instances of lesions in which the foreign body is fixed between the edges of the wound of exit.

Table 2, which represents the end-results for the various groups of double perforation, proves that this distribution corresponds to the facts. I have chosen as the chief indicator of the end-results the acuity of vision.

CONCLUSIONS

As observations of this kind are relatively scarce, our material may be regarded as considerable. At any rate it allows one to draw some conclusions, the most important of which are these:

1. The number of cases of complete double perforation of the eyeball in which the injuring object was lying freely in the orbit amounted to only one-half the number of cases of double perforation of the eye (nineteen among thirty-seven cases).

2. The number of instances in which the foreign body had caused a perforating lesion but had stuck between the edges of the posterior portion of the channel of the wound or, having entered the orbit, was located close to the wound of exit, also amounted to about 50 per cent of all the cases.

3. The following conclusions were found to be justified, all other conditions being equal:

- (a) In cases of *perforatio bulbi duplex completa* the prognosis is better than in cases of double perforation belonging to each of the other two groups. Eight of the nineteen patients have completely lost their vision, but six patients have retained good eyesight.

- (b) In cases of *perforatio bulbi duplex fere completa* the end-results are more unfavorable than in those of the first group. Five of the nine patients became completely blind in the injured eye, while the others retained only minimal vision.

- (c) The gravest cases are those of *perforatio bulbi duplex cum inelavatione*. Among nine patients with this injury there were six who lost their eyesight. The remainder retained only a minimal acuity of vision.

4. All the aforementioned kinds of trauma must be regarded as double perforation, though they ought to be differentiated according to the diagram I have just submitted (fig. 2).

5. An analysis of the clinical material according to this more precise classification will doubtlessly enrich the experience in this important problem.

EXPERIMENTAL STUDIES OF OCULAR TUBERCULOSIS

I. RELATION OF OCULAR SENSITIVITY TO CUTANEOUS SENSITIVITY IN THE SYSTEMICALLY INFECTED RABBIT

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In a previous study from the Wilmer Ophthalmological Institute¹ the factors responsible for the infection of the human eye with tubercle bacilli, for the extension and progression of such local tuberculous lesions and for their limitation and healing were discussed in the light of modern investigations. It was pointed out that ocular tuberculosis is in the main dependent on hematogenous infection arising from tuberculous lesions elsewhere in the body, usually from the hilus glands, and is only infrequently associated with active pulmonary lesions. The extension and progression of an established tuberculous lesion are due to hypersensitivity of the tissues of the eye to tuberculoprotein and to low resistance and are influenced by the number and the virulence of the invading bacilli. The limitation and healing of the tuberculous lesion are associated with low tissue sensitivity and high resistance, and are also influenced by the number and the virulence of the bacilli. In short, the inflammatory caseating and necrotizing phases of ocular tuberculosis are due to allergy, while encapsulation and healing of the lesion are due to immunity. Allergy and immunity are apparently quite unrelated, being two distinct entities. The nature of tuberculous allergy is fairly well understood, being a sensitization of the tissues by tuberculo-protein, or tuberculin, diffusing out from a tuberculous lesion. The nature of immunity is not clearly understood, but certainly there are two factors—a humoral and a cellular factor.

This work was supported by a grant from the John and Mary R. Markle Foundation.

From the Wilmer Ophthalmological Institute of the Johns Hopkins University and Hospital.

1. Woods, A. C.: The Problem of Ocular Tuberculosis, *Am. J. Ophth.*, to be published.

In the light of these concepts, it was pointed out that the rationale of treatment of ocular tuberculosis lies in the removal of the fatal tissue hypersensitivity and the promotion of immunity. Tuberculin was formerly used for the treatment of this condition on the basis of the so-called "perifocal" concept. According to this concept, allergy and immunity are related, and immunity may be stimulated by the production of minimal perifocal allergic reactions about the focus of infection; the subsidence of the lesion indicates that immunity is established, and when the minimal lesions are produced the tuberculin is no longer needed, and its administration should therefore be discontinued. However, on the basis of the concept that allergy and immunity are unrelated, this use of tuberculin to promote perifocal minimal reactions appears to be an error. It should be used properly as a desensitizing agent, with the aim of achieving and maintaining desensitization of the tissues and of allowing the not clearly understood immunity to accomplish the encapsulation and healing of the lesion. To this end tuberculin should be used in minimal doses just beneath the patient's individual point of reactivity and should be used over long periods, irrespective of the subsidence of the lesion, to maintain any desensitization accomplished and to prevent resensitization from the quiescent local lesion. This was termed the "desensitization" concept.

In a second communication² the results of these two different methods of using tuberculin in the treatment of human ocular tuberculosis were reported. It was shown that distinctly better results were obtained when tuberculin was used on the basis of the desensitization concept than when it was used on the basis of the perifocal concept. These improved results were manifested both in the healing of the local lesion and in the prevention of recurrences. The influence and value of other therapeutic procedures, such as climatic treatment, drainage of the aqueous, autohemotherapy and various forms of phototherapy, were also discussed.

In relation to the fundamental tuberculin therapy, the difficulties of administering tuberculin to certain persons and of achieving and maintaining desensitization of the tissues were emphasized. It was further pointed out that there were distinct gaps in the knowledge of the relation of ocular and cutaneous sensitivity, of the influence of the local ocular lesion on ocular sensitivity and of the action of tuberculin administered subcutaneously on the remote ocular lesion. In the effort to clarify these fundamental points, the present investigations were undertaken.

2. Woods, A. C., and Randolph, M. E.: The Treatment of Ocular Tuberculosis, *Arch. Ophth.* **18**:510 (Oct.) 1937.

CUTANEOUS AND OCULAR SENSITIVITY

The aim in the treatment of ocular tuberculosis with tuberculin on the basis of the desensitization concept is to abolish ocular sensitivity. There is, however, no clinical method of determining the degree of ocular sensitivity in a tuberculous eye, and the degree of cutaneous sensitivity present has been accepted as an index of the ocular sensitivity. There is abundant indirect evidence that these are not always parallel. Studies of cutaneous sensitivity to tuberculin in persons with clinically and with histologically diagnosed ocular tuberculosis³ have shown that in 53 and 60 per cent, respectively, there was an extreme degree of cutaneous hypersensitivity, the patients reacting to an intracutaneous dose of tuberculin of 0.001 mg. or less. Forty-two per cent of those with clinically diagnosed ocular tuberculosis and 20 per cent of those with histologically proved ocular tuberculosis showed only a moderate degree of cutaneous hypersensitivity, reacting only to 0.01 or 0.1 mg.—little more hypersensitivity than is found in a normal person. The remaining patients, 5 per cent of those for whom the diagnosis was proved clinically and 20 per cent of those for whom it was proved histologically, were nearly or totally insensitive cutaneously, reacting only to 1 mg. or not at all. With the first group of patients, those with high cutaneous sensitivity, there is probably justification for assuming that there is also a high degree of ocular sensitivity, and the therapeutic use of tuberculin may be undertaken with reasonable confidence. With the other two groups of patients, those with moderate or low cutaneous sensitivity, the use of tuberculin can be justified only on the assumption that cutaneous and ocular sensitivity in these persons are not parallel and that there exists a definite degree of ocular sensitivity to be attacked by the subcutaneous injection of tuberculin, either through its general effect or through a local effect by the mobilization and concentration of the injected tuberculin about the inflamed and hypersensitive focus.

One of the primary aims of these studies was to determine what relation, if any, exists between cutaneous and ocular sensitivity. In order to simulate the condition under which ocular tuberculosis occurs in human beings, this must finally be determined in animals previously inoculated systemically with tubercle bacilli and later inoculated intraocularly. However, before this can be studied and the results properly evaluated, the relation of ocular and cutaneous sensitivity in the animal with systemic tuberculosis only must be determined. The first problem, therefore, is to determine to what extent the eye participates in the hypersensitivity to tuberculin in the animal with systemic tuberculosis. The purpose of this paper is to report investigations on this question.

3. Friedenwald, J. S., and Dessoff, J.: Value of Intracutaneous Tuberculin Test in Diagnosis of Ocular Tuberculosis, *Bull. Johns Hopkins Hosp.* 57:148, 1935.

TECHNIC

Preparation of Cultures.—In preliminary experiments considerable difficulty was experienced with the stock strains of tubercle bacilli. In rabbits infected with the avirulent R1 bacillus, neither cutaneous sensitivity nor tuberculous lesions developed. On rabbits infected with the virulent H37 strain, sensitivity or local lesions developed only irregularly. In May 1935 a strain of tubercle bacilli which was highly virulent for guinea pigs was isolated from human sputum. This organism was used throughout this experiment. It was cultured either in the synthetic medium of Proskauer and Beck⁴ or on hormone bouillon containing 5 per cent glycerine, adjusted to a p_H of 7. The age of the cultures used varied from four to eight weeks.

Choice of Animals.—With the idea of avoiding any possible strain or age tendency toward sensitization or immunity, mongrel rabbits of various ages and breeds were used throughout this experiment.

Inoculation.—Systemic infection was obtained by subcutaneous injection in the groin of 0.25 cc. of a thick salt solution emulsion of living tubercle bacilli.

Sensitization Tests.—All tests for both cutaneous and ocular sensitivity were done with the purified protein derivative of the tubercle bacillus, isolated first by Seibert.⁵ The commercial preparation was used. This preparation is entirely non-antigenic, and any confusion of results incident to possible sensitization of the rabbits through repeated doses was therefore avoided. A stock solution containing 0.5 mg. per cubic centimeter in physiologic solution of sodium chloride with 0.5 per cent cresol U. S. P. was prepared. On the day the tests were done, dilutions of this stock solution of 1:10, 1:100 and 1:1,000 were made. The cutaneous sensitivity was determined by injecting 0.1 cc. of these dilutions intracutaneously into the clipped backs of the rabbits, the test doses therefore being 0.005, 0.0005 and 0.00005 mg. At the end of forty-eight hours these tests were read for erythema, elevation, induration and necrosis on a scale of from 0 to 4. The final result, indicating the degree of cutaneous sensitivity present, was estimated from these readings, again on a scale of from 0 to 4. The ocular sensitivity was determined by the injection of the purified protein derivative into the anterior chamber of both eyes, 0.01 mg. being injected into the right eye and 0.001 mg. into the left eye. Local anesthesia was used for the injections into the anterior chamber. The needle of the syringe, containing 0.2 cc. of the solution to be injected, was introduced into the anterior chamber, the aqueous was withdrawn and the mixture was pushed back and forth several times. It had been ascertained by previous experiments that ten times this dose of purified protein derivative, 0.1 mg., gave no reaction when similarly injected into the anterior chamber of the eye of a normal rabbit.

The eyes were examined clinically forty-eight hours after the injection. The degree of ciliary injection, steaminess of the cornea, turbidity of the aqueous, inflammatory change in the iris and any ophthalmoscopic change were noted individually in each eye and evaluated on a numerical scale of from 0 to 4. An

4. Proskauer, B., and Beck, M., cited by Baldwin, E. R.; Petroff, S. A., and Gardner, L. S.: *Tuberculosis: Bacteriology, Pathology and Laboratory Diagnosis with Sections on Immunology, Epidemiology, Prophylaxis and Experimental Therapy*, Philadelphia, Lea & Febiger, 1927.

5. Seibert, F. B.: Isolation and Properties of Purified Protein Derivative of Tuberculin, *Am. Rev. Tuberc.* 30:713, 1934.

average of these readings gave a numerical index of the degree of reaction in each eye, and the degree of ocular sensitivity was finally expressed as an average of the reaction in the two eyes.

The animals were then killed and the eyes were enucleated, sectioned and studied histologically by one of us, without knowledge of the clinical reading. On the same scale, from 0 to 4, numerical values were assigned to the degree of pericorneal infiltration present, to cellular deposits on the cornea, to serum in the anterior chamber and to the cellular reaction on the iris and the ciliary body. An average of these readings from the two eyes gave a final numerical value to the degree of the histologic reaction.

Controls.—To control any traumatic reaction, and as a control for the solution of purified protein derivative used, a normal rabbit was given intracutaneous and intra-ocular injections at the same time as each pair of test animals and was similarly killed and studied.

Outline of Experiment.—Forty-eight normal rabbits were first given an intracutaneous test injection of purified protein derivative and were found to be insensitive. They were then infected systematically by an injection of living human tubercle bacilli into the groin. At intervals of one week two of these animals were tested both for cutaneous and for ocular sensitivity and were then killed so that the tested eyes could be examined histologically. A normal rabbit was similarly tested and killed each week to serve as a control on the two test animals. There were available, therefore, two observations on both the cutaneous and the ocular sensitivity of systemically infected animals at weekly intervals over a period of sixteen weeks during the progressive stages of the tuberculous infection. The observations were necessarily made on different animals, but all were infected at the same time with the same inoculum. To determine the late outcome of the infection and the duration of the cutaneous and the ocular sensitivity, seven additional animals were systemically infected, and the sensitivity was determined eight months after inoculation.

RESULTS

Course of Systemic Infection.—Human tuberculosis in rabbits is a self-limited disease which does not kill the rabbit, the infection usually being overcome within four months. The rabbits in this experiment thrived and gained weight after the systemic inoculation. About two weeks after the injection into the groin, a nodule varying in size from 1 to 3 cm. in diameter appeared at the site of inoculation. Rarely did a rabbit show general lesions of disseminated tuberculosis. The animals on which autopsy was performed up to eight months after infection, with one exception, did not show gross or histologic evidence of generalized tuberculosis. The tuberculous process was limited, as a rule, to the local lesion at the site of inoculation.

Relation of Ocular and Cutaneous Sensitivity.—Graphs can best demonstrate the relation of the cutaneous and the ocular sensitivity. Since two animals were killed each time observations were made, three graphs were obtained illustrating, respectively, the cutaneous sensitivity and the clinical and the histologic sensitivity of the eye. These are

shown in charts 1 and 2. Chart 1 shows the ocular and the cutaneous sensitivity of the rabbits which each week showed the highest degree of cutaneous sensitivity, and chart 2 shows the same data for the rabbits which manifested the lowest degree of cutaneous sensitivity.

With minor variations, the curves are in the main similar, varying chiefly in the degree of reaction. Both cutaneous and ocular sensitivity first appeared synchronously at the end of the third week after inocu-

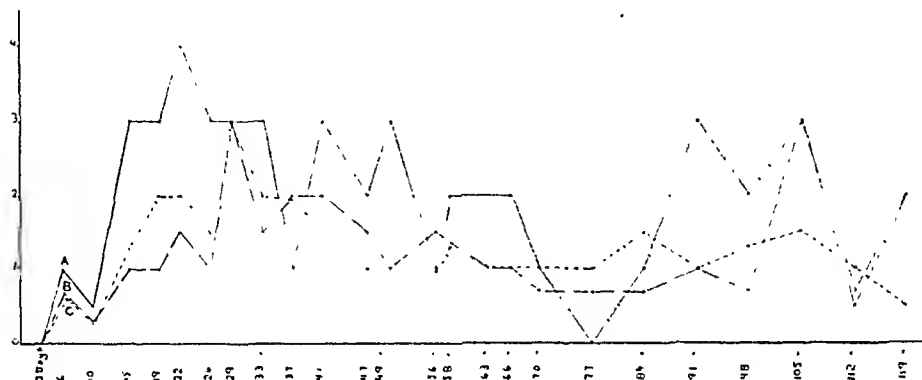


Chart 1.—Curves showing the degree of ocular and cutaneous sensitivity in the systemically infected rabbits that showed the highest degree of cutaneous reactivity. In this chart and in chart 2 curve *A* represents the cutaneous sensitivity; curve *B*, the clinical ocular sensitivity, and curve *C*, the histologic ocular sensitivity.

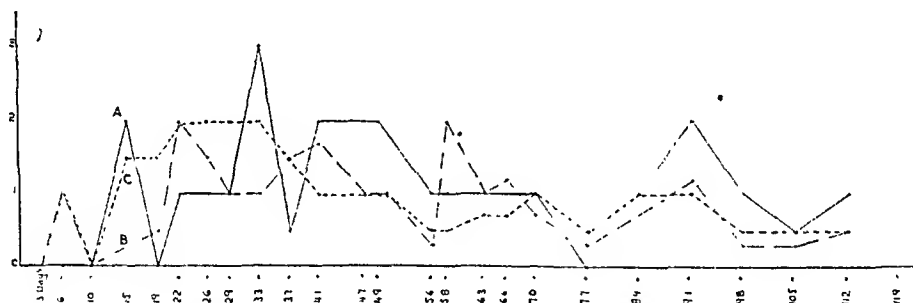


Chart 2.—Curves showing the degree of ocular and cutaneous sensitivity in the systemically infected rabbits that showed the lowest degree of cutaneous reactivity.

lation and reached their peak from six to eight weeks after systemic inoculation. Thereafter they fluctuated within minor limits for a further period of from six to eight weeks, when a fairly constant equilibrium was reached. At the end of four months both cutaneous and ocular sensitivity were present to a moderate and approximately equal degree. At the end of eight months, when the last rabbits were killed, the degree of both cutaneous and ocular sensitivity was only slightly less than that at the end of four months, the cutaneous and the ocular sensitivity measuring $1+$ on the scale of from 0 to 4 (charts 1 and 2).

COMMENT

As the test animals were killed each week to permit histologic examination of the tested eyes, the weekly estimations of the degree of sensitivity are for different animals. Although the animals were all similarly infected at the same time, the results are nevertheless subject to individual variation in susceptibility to sensitization. Despite this possible source of confusion, the curves of both ocular and cutaneous sensitivity are remarkably parallel and show clearly that the normal eye apparently participates equally in the general sensitivity to tuberculo-protein shown by other body tissues. This is emphasized by the fact that the animals chosen for the lower degree of cutaneous sensitivity likewise showed a lower degree of ocular sensitivity.

Two sharp breaks occur in the curves of cutaneous sensitivity, the estimation on the thirty-seventh and the seventy-seventh day being markedly lower than on either the preceding or the following weeks. The cause of this sharp decrease in cutaneous sensitivity, without noticeable change in either the clinical or the histologic ocular sensitivity, is not clear. It seems more probable it is due to some technical error on our part than to individual variation in the susceptibility of the test animals. The other minor fluctuations in cutaneous sensitivity shown throughout may be due to a variety of causes, such as individual variations in the rabbits or possibly the result of environment or weather on the reactivity of the skin.

The close parallelism of the curves illustrating the clinical and the histologic degree of ocular sensitivity are rather remarkable, especially since these estimations were made independently by different investigators, the histologist having no knowledge of the value assigned the clinical reactions.

CONCLUSIONS

Under the conditions of this experiment, the undiseased eyes of rabbits infected systemically with human tubercle bacilli participate in the general sensitivity to tuberculo-protein developed by the skin. Both ocular and cutaneous sensitivity develop synchronously about the third week and reach their peak about the sixth to the eighth week. Thereafter they fall slightly and reach an equilibrium but are still present eight months after the original inoculation.

The cutaneous sensitivity gives a fairly reliable index of the degree of ocular sensitivity in the systemically infected rabbit with undiseased eyes.

The Mulford Biological Laboratories, Sharp & Dohme, supplied the purified protein derivative used in these tests, and Miss Rosa Himelfarb gave technical assistance.

EXPERIMENTAL STUDIES OF OCULAR TUBERCULOSIS

II. RELATION OF OCULAR ACTIVITY TO OCULAR SENSITIVITY IN THE NORMAL RABBIT INFECTED BY INJECTION OF TUBERCLE BACILLI INTO THE ANTERIOR CHAMBER

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In the first paper of this series,¹ attention was directed to certain phases of the general problem of ocular tuberculosis and especially to the rudimentary state of knowledge concerning the relation of cutaneous sensitivity, ocular sensitivity and ocular activity. The results of an investigation on the relation of cutaneous and ocular sensitivity in the normal rabbit infected by systemic injection of human tubercle bacilli were reported. Ocular sensitivity was found to develop synchronously with cutaneous sensitivity, the nondiseased eyes participating in the general development of tissue sensitivity. With minor variations, during the course of this self-limited disease in the rabbit cutaneous and ocular sensitivity ran fairly parallel, reaching their peak from six to eight weeks after systemic inoculation, declining slightly as the animal overcame the infection, but being definitely present for at least nine months after infection, when the last rabbits were tested.

The next step in this study is the determination of the mutual influence and relation of local tuberculous inflammation and ocular sensitivity. That some change in ocular sensitivity may follow an attack of tuberculous inflammation was indicated by an inconclusive experiment on human eyes.² In this experiment, performed on eyes already

This work was supported by a grant from the John and Mary R. Markle Foundation.

From the Wilmer Ophthalmological Institute of the Johns Hopkins University and Hospital.

1. Woods, A. C.; Burky, E. L., and Friedenwald, J. S.: Experimental Studies of Ocular Tuberculosis: I. Relation of Ocular and Cutaneous Sensitivity in the Systemically Infected Rabbit, *Arch. Ophth.*, this issue, p. 229.

2. Woods, A. C.: The Problem of Ocular Tuberculosis, *Am. J. Ophth.*, to be published.

lost because of repeated former attacks of tuberculous uveitis, it was found that the vascular reactivity of these eyes to tuberculin, as determined by a graduated Calmette reaction, was lessened or exhausted with the subsidence of an exacerbation of the local inflammation.

The purpose of this paper is to report the results of experiments on the relation between tuberculous inflammation and ocular sensitivity in normal animals infected ocularly by injections of tubercle bacilli into the anterior chamber. It is apparent that this picture of ocular tuberculosis in an otherwise normal animal is an artificial experimental condition, in no way comparable to the picture of ocular tuberculosis in man, in whom the ocular disease is secondary to some systemic focus. Nevertheless, the relation between ocular activity and ocular sensitivity must be determined first in the normal animal in order that it may later be properly studied and interpreted in the animal with a previous systemic infection and a secondary ocular infection.

PLAN OF EXPERIMENT

Forty-eight normal rabbits were first tested intracutaneously with 0.05 mg. of purified protein derivative of the tubercle bacilli and were found to be insensitive. They were then inoculated by means of a suspension of living tubercle bacilli injected into the anterior chamber. The entire group was tested intracutaneously at weekly intervals with graduated doses of purified protein derivative to determine the development of cutaneous sensitivity. The eyes were examined clinically each week, and the amount of tuberculous activity present was estimated. Again, at weekly intervals, simultaneous with the determination of cutaneous sensitivity, the degree of ocular sensitivity of each eye was determined in two of the rabbits by clinical examination of the eyes after the intra-ocular injection of purified protein derivative. The two animals were then killed, and the eyes were sectioned and examined histologically to determine the histologic evidence of allergy, the reaction produced by the injection of purified protein derivative and the course of the tuberculous infection. For each pair of experimental animals, a normal control animal was given a similar injection, and the eyes were sectioned and studied.

Six eyes perforated spontaneously as a result of tuberculous uveitis and became secondarily infected. These animals were discarded, leaving forty-two rabbits, which formed the material for this experiment.

TECHNIC

Preparation of Cultures.—A salt solution emulsion of the same human bacillus used in the first experiment was prepared as already described. For intra-ocular injection, this emulsion was filtered through filter paper, an opalescent suspension resulting. A smear was made, which was stained and examined under oil immersion, and the number of bacilli present were counted. Usually from 50 to 500 organisms were present to each oil immersion field. This paper filtrate of the original emulsion was then diluted from 1:10 to 1:100, according to the number of bacilli present, the aim being to have a final suspension containing approximately 5 organisms to each oil immersion field.

Animals and Inoculation.—Mongrel rabbits of varying age and breed were used, as in the first experiment. The right eye of each rabbit was inoculated by means of an injection into the anterior chamber of 0.2 cc. of the final suspension, the mixture of aqueous and bacilli being withdrawn and reinjected several times to insure a uniform suspension of the bacilli in the anterior chamber. Local anesthesia was used. This dosage and method of inoculation had been shown by previous experiment to produce in the rabbit a fairly uniformly progressive ocular tuberculosis with subsequent scarring.

Determination of Cutaneous and Ocular Sensitivity.—Cutaneous sensitivity was determined in the manner described before. The rabbits were all tested weekly by the intracutaneous injection in the clipped back of 0.005, 0.0005 and 0.00005 mg. of purified protein derivative. The results were read at the end of forty-eight hours for erythema, elevation, induration and necrosis on a scale of from 0 to 4, the final average being the numerical value assigned to the cutaneous reaction.

The ocular sensitivity was determined synchronously on two animals by the intra-ocular injection of 0.01 mg. of purified protein derivative into the anterior chambers of both the inoculated right eye and the normal left eye, it having been previously determined that ten times this dose produced no reaction when injected in the anterior chamber of a normal rabbit's eye. Immediately before the injection of purified protein derivative, the degree of ocular activity in the diseased eye was carefully noted. At the end of forty-eight hours the eyes were again examined, and the degree of activity then present was noted. The amount of heightened inflammation or the difference in inflammation before and after the injection represents the vascular reaction of these eyes to the purified protein derivative.

The animals were killed, and the eyes were enucleated, sectioned and studied histologically. Throughout the progressive stages of the disease, the normal left eye showed a definite cellular reaction to the injection of purified protein derivative, and by estimation of the periorbital infiltration, the cellular deposits in the cornea, the amount of serum in the anterior chamber and the cellular reaction of the iris and ciliary body, a numerical value could readily be assigned, indicating the degree of histologic sensitivity. Caseation and necrosis were never observed in these eyes.

In the inoculated right eye, the situation was quite different. During the first four weeks of the disease it was impossible by histologic examination to differentiate the reaction caused by the injection of purified protein derivative from the diffuse tuberculous infiltration caused by the bacilli themselves. In the fifth week typical allergic caseation and necrosis became evident and persisted to a high degree up to the sixteenth week, with little variation. From the sixteenth to the twenty-first week caseation and necrosis rapidly subsided, and the eyes showed scarring and evidence of repair.

The histologic evidence, therefore, indicates that allergy, or hypersensitivity of the ocular tissues, was present from the fifth to the sixteenth week after inoculation. Some caseation was seen clinically in these eyes before the injection of purified protein derivative. The caseation and necrosis observed histologically may therefore have been due to two factors, a reaction secondary to the tuberculous inflammation and a reaction to the purified protein derivative. The relatively mild scarring present in the eyes enucleated in the last five weeks of the experiment, when caseation due to the tuberculous inflammation was in process of repair, would indicate that the greater portion of the caseation and necrosis was due to the injection of purified protein derivative. This is, however, an academic point. Suffice it to say, histologic examination revealed evidence of a high degree of hypersensitivity from the fifth to the sixteenth week after inoculation, and thereafter allergy faded rapidly.

The correlation of the clinical and histologic estimations of ocular sensitivity is complicated by the fact that from the eighth to the sixteenth week the injection of purified protein derivative into the anterior chamber produced little accentuation of the inflammatory reaction in the diseased eyes. During this period the tuberculous eyes showed opaque and vascularized corneas, clinical evidence of caseation and a rapidly subsiding vascular reaction. It was at first not clear whether this absence of accentuation of the vascular reaction after the injection of purified protein derivative was due to subsidence of the ocular sensitivity or to a blocking off of the blood vessels by the caseation and cellular infiltration and a consequent loss of vascular response to any stimulus. The diseased eyes of control animals in this stage of tuberculosis were therefore inoculated by injection of living virulent staphylococci into the anterior chamber. In normal eyes this injection produced a marked vascular and pyogenic reaction. In the caseating tuberculous eyes, apparently nonreactive to the purified protein derivative, the injection of staphylococci produced no vascular reaction and almost no pyogenic reaction. It is therefore evident that the apparent lack of reaction to purified protein derivative should not be attributed to a lack of ocular sensitivity but was probably due to vascular nonreactivity secondary to the blocking off of the blood vessels by caseation. Only after the sixteenth week, when the caseation subsided, was a moderate return of the vascular reaction to the injection of purified protein derivative noted.

Plotting of the Graph of Ocular Sensitivity.—A graph plotted to demonstrate ocular sensitivity must therefore be a composite one. In the first four weeks, before caseation was apparent, the heightened inflammation observed clinically after the injection of purified protein derivative gave the most reliable index of the ocular sensitivity, for the reaction produced could not be differentiated histologically from the tuberculous infiltration caused by the bacilli. After the appearance of caseation and necrosis, when the vascular reactivity of the eye to purified protein derivative began to fade, histologic evidence indicated a maximal ocular sensitivity up to the sixteenth week. Thereafter there was histologic evidence of rapidly subsiding ocular sensitivity associated with a mild degree of clinical vascular reaction. On the basis of this information, the graph of ocular sensitivity was plotted. The graph for the first four weeks was plotted on the clinical estimations of allergy; that for the next twelve weeks, on the histologic evidence of allergy, and that for the last five weeks, on the mean of the clinical and histologic estimations.

Course of Ocular Tuberculosis (Ocular Activity).—The clinical picture of ocular tuberculosis developed by all these rabbits was limited to the anterior ocular segment. As long as the cornea and aqueous remained sufficiently clear to permit ophthalmoscopic examination of the fundus, no lesions were observed in the retina or choroid or about the optic nerve. Histologic examination of the enucleated eyes, however, showed in addition to the tuberculous inflammation of the anterior ocular segment an occasional spread of the reaction to the posterior segment.

The two rabbits killed in the first two weeks did not yet show any clinical signs of ocular tuberculosis. One other rabbit was apparently highly immune and showed little inflammatory reaction. The pericorneal congestion in this rabbit was only moderate, the cornea remained clear and the vascularization present was limited to a small zone at the periphery. The iris uniformly showed chronic thickening and loss of normal luster and markings, with numerous hard tubercles studded over the anterior surface. The course of the ocular tuberculosis in the remaining thirty-nine rabbits was more or less constant, with minor individual variations.

The greater number of the rabbits, thirty-five, or 80 per cent of the entire number, showed, first, a slowly progressive inflammation, beginning about two weeks after inoculation and characterized by pericorneal congestion and steaminess and later by vascularization of the cornea, an increase in the aqueous ray and chronic inflammatory changes in the iris, often with tubercle formation. This indolent reaction gradually became aggravated about the fourth week, and the eyes entered the second stage, with aggravated inflammation and obvious caseation and necrosis. Four of these thirty-five eyes finally perforated. In four rabbits the inflammation and caseation were more acute, the eyes perforating within six weeks. The acute inflammation, as manifested by the vascular reaction, began to subside about the eighth week, and by the tenth week there was only low grade ciliary inflammation. For the next six weeks the eyes showed a caseating

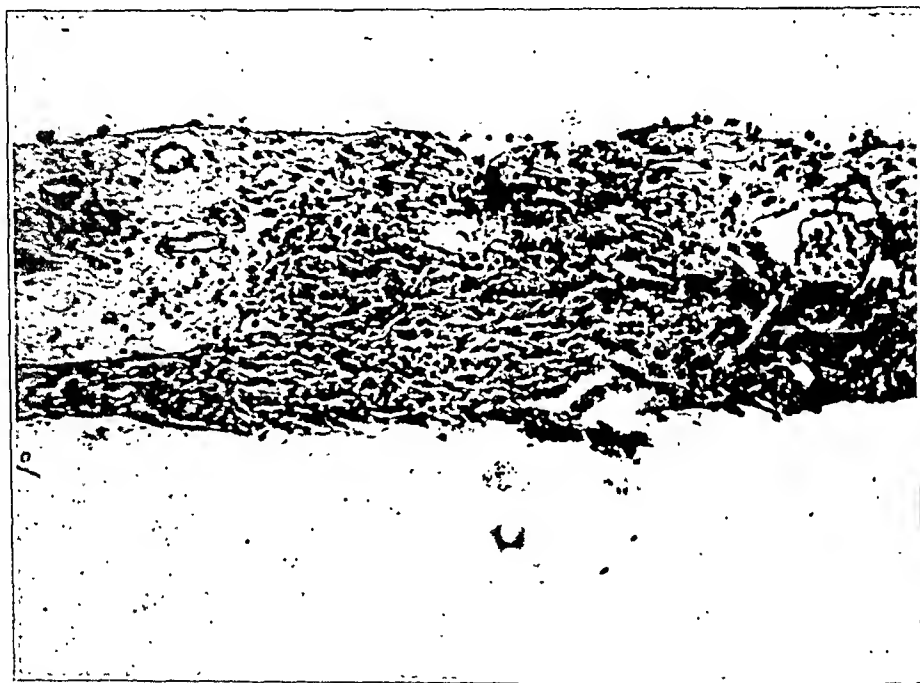


Fig. 1.—Section of the eye four weeks after inoculation of the anterior chamber, showing a hard tubercle of the iris.

inflammation and little vascular reaction. Thereafter they entered the third stage, of scarring and repair. The eyes that were enucleated in the last five weeks of the experiment showed, with one exception, scarred and vascularized corneas, often buphthalmos or corneal ectasia, but no active congestion or necrosis.

The histologic reaction of the enucleated eyes showed that the entire reaction during the twenty-one weeks fell roughly into three general stages. During the first four weeks there was diffuse tuberculous infiltration with hard tubercles, masked somewhat by the reaction incident to the injection of purified protein derivative (fig. 1). From the fifth to the sixteenth week the eyes showed extension of the inflammation, caseation and necrosis with masses of dead epithelioid cells (fig. 2). From the sixteenth to the twenty-first week, when the experiment was terminated, with only one exception, the eyes were free from caseation and showing evidence of healing and repair (fig. 3).



Fig. 2.—Section of the eye eight weeks after inoculation of the anterior chamber, showing caseation and necrosis of the iris.

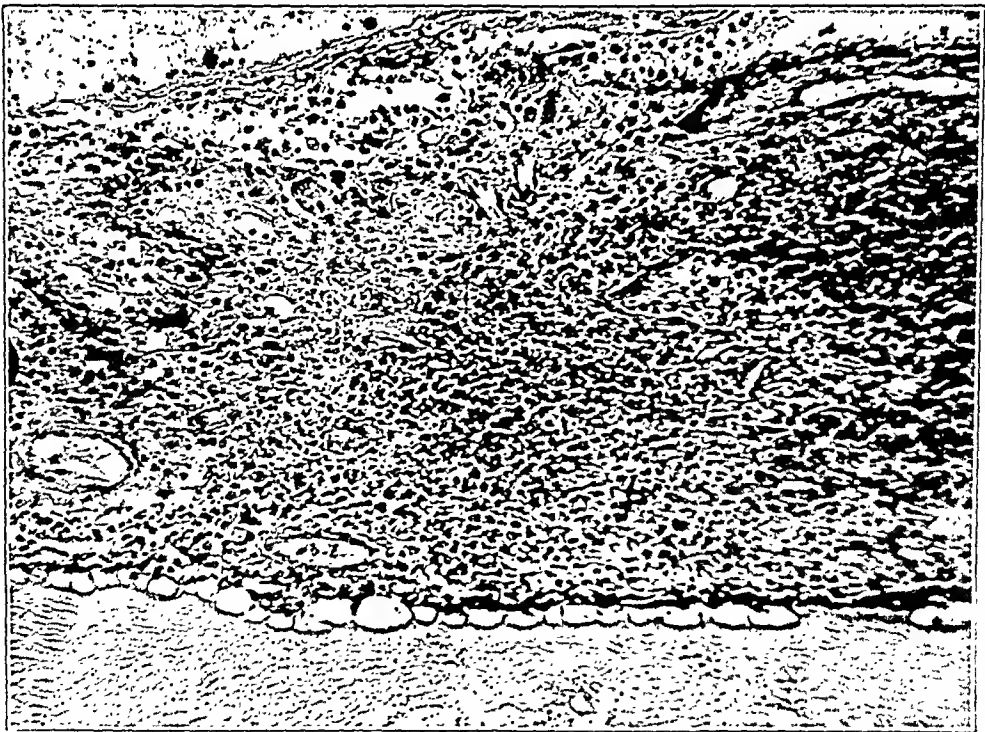


Fig. 3.—Section of the eye twenty weeks after inoculation of the anterior chamber, showing connective tissue infiltration and repair.

The first clinical stage, of infiltration, and the final stage, of inactivity and repair, agree well with the histologic picture. The second clinical stage of acute vascular inflammation, from the fourth to the tenth week, was much shorter than the histologic stage of acute inflammation, which persisted up to the sixteenth week. This discrepancy was due to the loss of vascular reactivity from the caseation. As already pointed out, the vascular reactivity of these eyes to purified protein derivative as well as to such a nonspecific irritant as living staphylococci was greatly reduced after the eighth week.

Plotting of the Graph of Ocular Activity.—The final graph of ocular activity was plotted as the mean of the clinical and histologic readings. The gradual drop of the curve after the eighth week reflects the loss of vascular reactivity. A graph plotted on the estimations of clinical activity only, as in figure 4, shows a much more striking apparent decrease in clinical inflammation occasioned by the loss of vascular reactivity. The curve slopes sharply downward after the eighth week.

The comparison of ocular activity and ocular sensitivity in this experiment is based on observations made on the two animals killed weekly. This introduces an element of individual variation. That this element is negligible is shown by

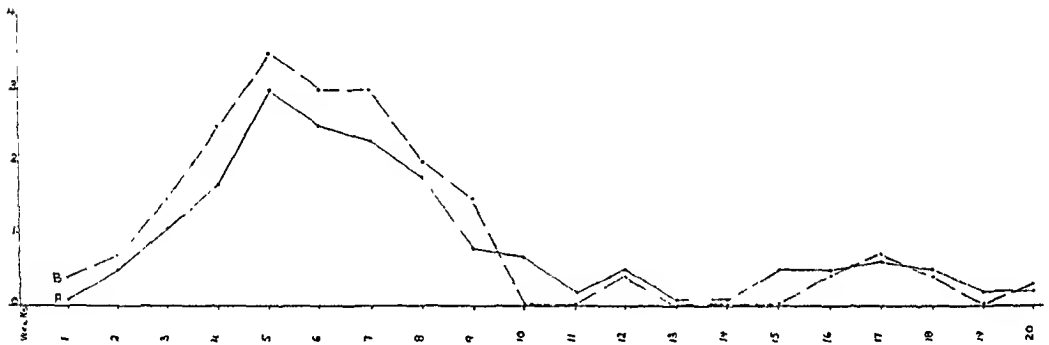


Fig. 4.—Average clinical ocular activity for the entire group of rabbits (curve A) and for the pairs of rabbits tested at weekly intervals (curve B).

figure 4. In this figure curve A shows the average clinical ocular inflammation shown by all the surviving rabbits of the group. Curve B shows the average clinical inflammation shown by the pairs of rabbits killed weekly. Since these curves are almost identical, it appears that the pairs of rabbits killed weekly are a fair sample of the entire group.

RESULTS

Relation of Clinical Ocular Activity and Ocular Sensitivity.—Figure 5 shows the graphs of clinical ocular activity and ocular sensitivity in the pairs of rabbits killed over the twenty-one weeks of the experiment. During the first five weeks after inoculation, while the tubercle bacilli propagated and the infection spread throughout the eye, inflammation and ocular sensitivity increased together to the maximum. After caseation and necrosis appeared in the fifth week, there was an apparent decrease in inflammation. There was still, however, a high degree of allergy present until the sixteenth week. At this point the allergic response of the tissues appeared exhausted, and both ocular sensitivity and inflammation rapidly faded. As already pointed out, the apparent

decrease in ocular activity from the fifth to the sixteenth week represents the loss of vascular reaction of the diseased eyes and is not an index of a fading ocular tuberculosis but only a reflection of the blocking off of the vascular network by the existing inflammation and caseation. Histologic evidence clearly shows that the spread of the tuberculous lesion and the sensitivity of the ocular tissues go hand in hand, and healing occurs only when the ocular sensitivity is diminished and abolished.

Relation of Recurrences to Resensitization.—In the latter weeks of this experiment three individual rabbits, which had apparently reached a stage of complete clinical inactivity, showed definite recurrences of inflammation, with a lighting up of the pericorneal inflammation and evidences of renewed activity. They were killed at this stage. The eyes showed a clinical reaction to the injection of purified protein derivative into the anterior chamber two days before the animals were killed. It is possible that the apparent exacerbation of the tuberculosis and syn-

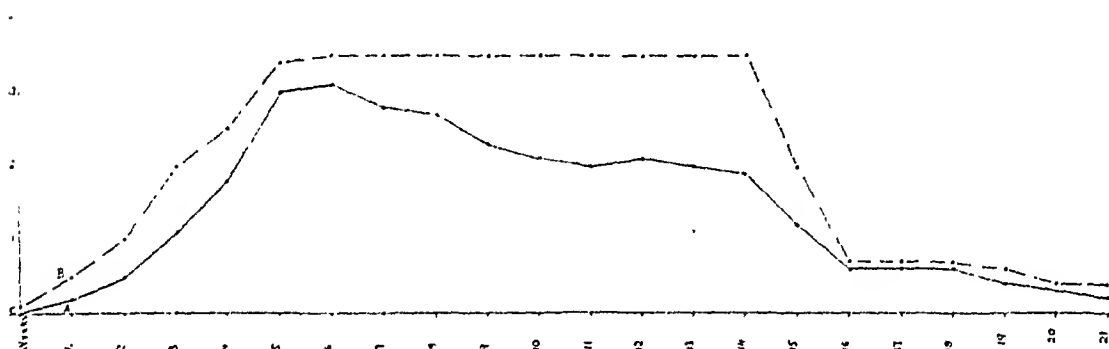


Fig. 5.—Curves showing the relation of ocular inflammation to ocular sensitivity. Curve *A* represents the ocular inflammation and curve *B*, the ocular sensitivity.

chronous return of reactivity of the eye to the purified protein derivative may be only an evidence of recurring vascular reactivity in the eye. On the other hand, it may indicate a resensitization of the tissues after a period of rest, with a resultant exacerbation of tuberculous infiltration. In either event, it is notable that the three rabbits which showed recurrences of inflammation also showed a return of clinical ocular reaction to the purified protein derivative.

COMMENT

The findings here reported give an experimental explanation for the already reported inconclusive experiment on human beings. The acute inflammatory stages of tuberculous ocular lesions appear only in the presence of sensitivity of the ocular tissues. Until demonstrable sensitivity is present in the eye, the tuberculous lesion runs a low grade,

smoldering course. The progression of the acute inflammatory stage is accompanied by a gradual diminution or exhaustion of the vascular reactivity of the eye. After the ocular sensitivity is exhausted, the eyes become quiescent, and healing and scarring occur. There is suggestive evidence in three rabbits that vascular reactivity to purified protein derivative and clinical exacerbations of the tuberculous activity occur synchronously.

The process might theoretically be visualized as follows: After infection of the normal eye with tubercle bacilli there is a steady propagation of the bacilli, invasion of tissues and tubercle formation. The diffusion of tuberculo-protein in the hitherto normal tissue produces first a tissue sensitization. After this is established, the further diffusion of tuberculo-protein from the lesion produces an allergic inflammatory reaction characterized by caseation and necrosis. With the neutralization of the tissue reagin, the allergic reaction subsides, and the eye becomes quiescent. Clinical inflammation may recur when the ocular tissues either recover their vascular reactivity or become resensitized.

How might this resensitization of the eye occur? In such animals as these, with the only tuberculous focus in the eye, it must be supposed that resensitization is the result of the continued diffusion of tuberculo-protein from the local lesion, resensitization occurring after the tissues have passed from a negative phase after neutralization of the available reagin into a positive susceptible phase. In the systemically infected animal, resensitization of the eye might readily take place from a remote lesion, it already having been shown that in the systemically infected animal the eye participates in the general tissue sensitivity.

CONCLUSIONS

After infection of the eyes of a normal rabbit with tubercle bacilli, the initial tuberculous process is a low grade tuberculous infiltration with formation of hard tubercles.

Ocular sensitivity to tuberculo-protein becomes apparent at the end of the second week and maximal by the fifth week.

With the establishment of ocular sensitivity, the eyes show an acute inflammatory phase. This acute inflammation is accompanied by caseation and necrosis and produces first an exhaustion of the vascular reactivity of the eye. This in turn is followed by an exhaustion of the ocular sensitivity, and synchronous with the fading of ocular sensitivity, healing and scarring are observed.

Recurrences of ocular activity occurred synchronously with the return of vascular reactivity to purified protein derivative.

The Mulford Biological Laboratories, Sharp & Dohme, supplied the purified protein derivative used in these tests, and Miss Rosa Himelfarb gave technical assistance.

EXPERIMENTAL STUDIES OF OCULAR TUBERCULOSIS

III. RELATION OF CUTANEOUS SENSITIVITY TO OCULAR SENSITIVITY IN THE NORMAL RABBIT INFECTED BY INJECTION OF TUBERCLE BACILLI INTO THE ANTERIOR CHAMBER

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In the first study of this series¹ it was found that in rabbits systemically inoculated with human tubercle bacilli the eye participated in the general body sensitivity developing after inoculation. Ocular sensitivity developed synchronously with cutaneous sensitivity, and, with minor variations, ran a fairly parallel course, the cutaneous sensitivity affording a reasonably accurate index of the sensitivity of the undiseased eyes. In the second study it was pointed out that when the normal rabbit was inoculated with tubercle bacilli in the anterior chamber and the primary tuberculous focus lay in the eye, ocular sensitivity began to develop about the second week after inoculation and reached its height in about four weeks. The eyes showed a slowly progressive tuberculous inflammation during the first few weeks, which became acute, with caseation and necrosis, as the ocular sensitivity developed to maximum. Active tuberculous inflammation and ocular sensitivity persisted steadily up to the sixteenth week, although about the eighth week there was some loss of vascular reactivity, apparently due to the blocking of the vascular bed by necrosis. From the sixteenth to the twenty-first week, when the experiment was terminated, the ocular sensitivity faded and the active inflammation subsided synchronously, the eyes thereafter showing evidence of scarring and repair. In the final stage of compara-

This work was supported by a grant from the John and Mary R. Markle Foundation.

From the Wilmer Ophthalmological Institute of the Johns Hopkins University and Hospital.

1. Woods, A. C.; Burky, E. L., and Friedenwald, J. S.: Experimental Studies of Ocular Tuberculosis: I. Relation of Ocular and Cutaneous Sensitivity in the Systemically Infected Rabbit, *Arch. Ophth.*, this issue, p. 229.

tive inactivity there were occasional minor exacerbations of inflammation. There was suggestive evidence that these exacerbations of activity were related to the presence or return of the ocular sensitivity.

The next step in these studies was an analysis of the relation of ocular sensitivity to cutaneous sensitivity in the normal rabbit inoculated intra-ocularly by means of an injection of tubercle bacilli into the anterior chamber.

OUTLINE OF EXPERIMENT

The rabbits on which this study was based are the same rabbits used in the second study on the relation of ocular sensitivity to ocular activity. Forty-eight normal rabbits were first proved insensitive to an intracutaneous injection of 0.005 mg. of purified protein derivative of tubercle bacilli. Then 0.2 cc. of a suspension of living human tubercle bacilli was injected into the anterior chamber of the right eye of each rabbit. During the course of the experiment six animals were discarded on account of perforation of the eyes, with secondary infection. At weekly intervals the eyes of all surviving rabbits were examined clinically, and a numerical value was assigned to the degree of tuberculous activity and inflammation present. The rabbits were likewise tested intracutaneously at the same time for cutaneous hypersensitivity to the purified protein derivative, to which a numerical value was assigned. Each week the ocular sensitivity of both the inoculated and the normal eye was determined by the injection of purified protein derivative into the anterior chamber of two rabbits, which were then killed for histologic examination of the tested eyes. There were therefore available for analysis weekly estimations of the cutaneous sensitivity and ocular activity of all the surviving rabbits, the number steadily diminishing as the experiment progressed, and estimations of the ocular sensitivity in both the inoculated and the normal eye of the separate pairs of rabbits killed in progressive stages of the ocular tuberculosis.

TECHNIC

The technic employed in inoculation and the determination of both cutaneous and ocular sensitivity has already been reported in the second paper of this series.²

The graph representing cutaneous sensitivity was based on the clinical reading of the intracutaneous tests with purified protein derivative. The graph representing ocular activity was based on the mean of the clinical and histologic estimations. As already pointed out, the subsidence of activity from the eighth to the sixteenth week is a reflection of the loss of vascular reactivity incident to the development of caseation and necrosis. The plotting of the graph of ocular sensitivity was explained in the second paper of this series. The graph for the first four weeks was based on the clinical examination; that for the ensuing twelve weeks, on the histologic examination of the eyes, and that for the final five weeks, on the mean of the histologic and clinical estimations.

2. Woods, A. C.; Burky, E. L., and Friedenwald, J. S.: Experimental Studies of Ocular Tuberculosis: II. Relation of Ocular Activity to Ocular Sensitivity in the Normal Rabbit Infected by Injection of Tubercle Bacilli into the Anterior Chamber, *Arch. Ophth.*, this issue, p. 236.

RESULTS

It was shown in the second study that the average clinical ocular activity of the group as a whole was practically identical with the average activity shown by the pairs of rabbits killed at weekly intervals, and therefore the individual pairs of rabbits appear to offer a reliable index of the reactions of the whole group.

Sensitivity in the Normal Uninoculated Eye.—As in the experiment with the systemically infected rabbits, sensitivity to purified protein derivative began to develop in the normal uninoculated eye at the second week; it reached a peak about the end of the third week, and thereafter continued, with minor fluctuations, during the twenty-one weeks of the experiment. The sensitivity in the normal eye declined only slightly during this period. Again, as in the systemically infected animal, the clinical and histologic estimations ran closely parallel. The graphs of these estimations are shown in chart 1. The ocular sensitivity shown by the normal uninoculated left eye of these rabbits was essentially

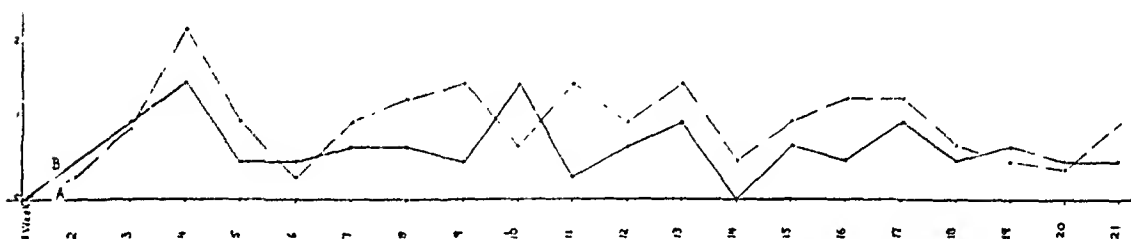


Chart 1.—Curves showing the histologic and the clinical sensitivity of the left eye after inoculation of the anterior chamber of the right eye with tubercle bacilli. Curve A represents the histologic sensitivity, and curve B, the clinical sensitivity.

of the same degree as that in the normal eyes of rabbits infected by systemic injection.

Development of Cutaneous Sensitivity.—Cutaneous reactions to purified protein derivative became evident at the end of the second week after inoculation of the anterior chamber, reached their peak about the fifth or the sixth week, then declined and, with minor fluctuations in intensity, continued at a low level during the twenty-one weeks of observation.

It is notable that the cutaneous reactions in these animals with the primary tuberculous focus in the eye were distinctly less than those in the systemically infected rabbits. In chart 2 the cutaneous reactions in the systemically infected rabbits, reported in the first study, may be compared with the cutaneous sensitivity of the rabbits in this experiment. In both instances the reactions represent the average of the pairs of rabbits killed weekly, and they were read and checked on the same scale. The cutaneous sensitivity which develops secondary to a local

tuberculous process in the eye appears to be decidedly less than that which develops after systemic infection.

Relation of Sensitivity in the Uninoculated Eye to Cutaneous Sensitivity.—The graphs illustrating the relation of sensitivity in the uninoculated eye to cutaneous sensitivity are shown in chart 3. The sensitivity of the undiseased eye and cutaneous sensitivity run approximately parallel. In this chart the ocular sensitivity is expressed as the mean of the clinical and histologic reading. Ocular sensitivity appears

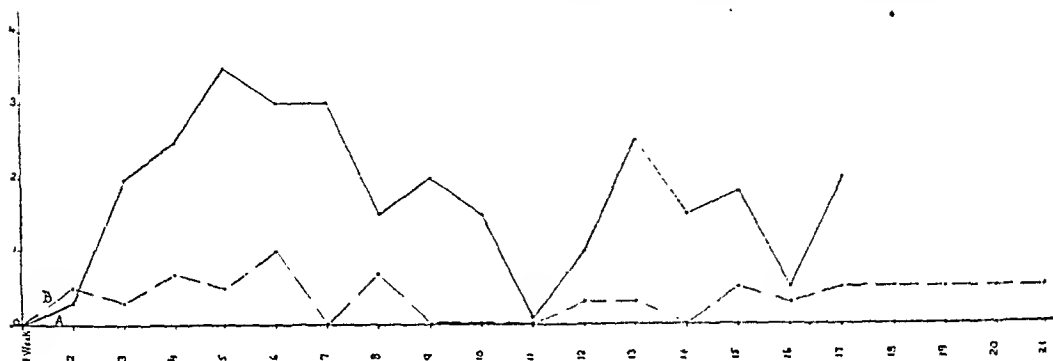


Chart 2.—Curves showing the relation of the cutaneous sensitivity of rabbits inoculated systemically to that of rabbits inoculated by an injection of tubercle bacilli into the anterior chamber. Curve *A* represents the cutaneous sensitivity of the first group, and curve *B*, that of the second group.

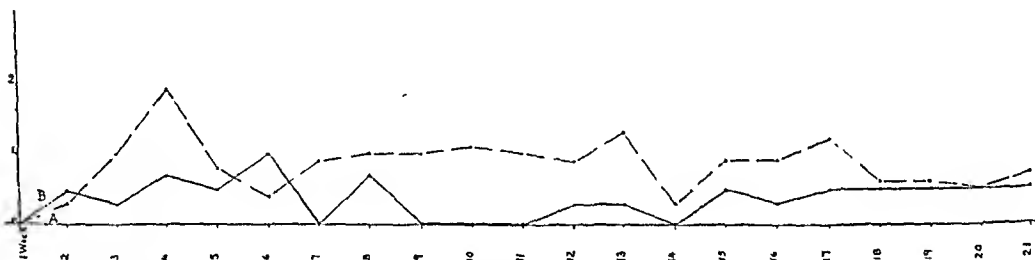


Chart 3.—Curves showing the relation of the ocular sensitivity of the left eye to cutaneous sensitivity after inoculation of the anterior chamber of the right eye with tubercle bacilli. Curve *A* represents the ocular sensitivity, and curve *B*, the cutaneous sensitivity.

to be slightly more marked than does cutaneous sensitivity and less subject to fluctuations. However, although both were charted on the same numerical scale, it is difficult to compare the degree of reaction in such completely different tissues. Certainly, however, the sensitivity of the uninoculated eye, as determined by the injection of purified protein derivative, appears more constant than does the cutaneous sensitivity.

Relation of Sensitivity in the Inoculated Diseased Eye to Cutaneous Sensitivity.—The graphs of ocular sensitivity in the diseased eye and of cutaneous sensitivity are shown in chart 4. The inoculated eye rapidly

became sensitive to tuberculo-protein, and this sensitivity reached a maximum by the fifth week. As before noted, the development of a high degree of ocular sensitivity was accompanied by an acute inflammatory phase of the ocular tuberculosis. Ocular sensitivity remained at a high level for approximately sixteen weeks, when it was neutralized or exhausted by the tuberculous inflammatory process. Thereafter sensitivity fell rapidly, the acute inflammation subsided synchronously and the eye showed evidence of repair and scarring.

Cutaneous sensitivity, on the other hand, was always of low degree. It first appeared about the second week, fluctuated slightly and reached its low maximum about the sixth week, synchronous with the development of the high ocular sensitivity. Thereafter cutaneous sensitivity fluctuated at a low level. At no time did it parallel ocular sensitivity, and certainly at no time during the ocular inflammation did cutaneous sensitivity give any index of the degree of ocular sensitivity.

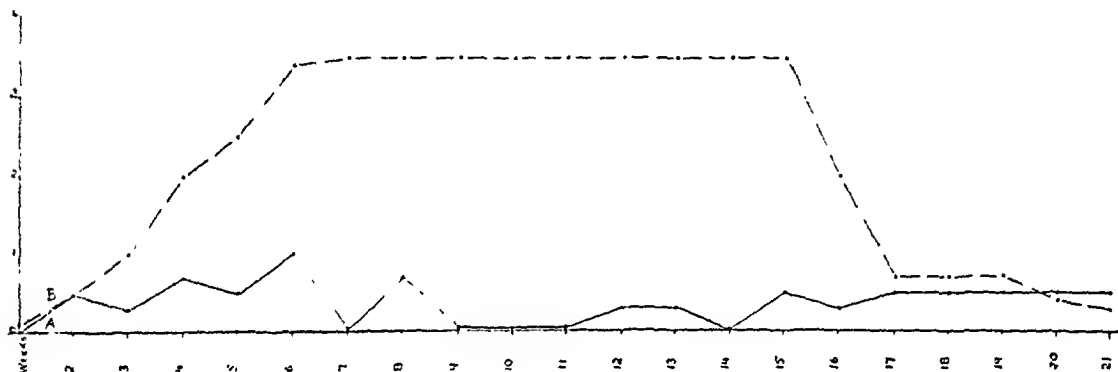


Chart 4.—Curves showing the relation of the ocular sensitivity of the right eye after inoculation of the anterior chamber with tubercle bacilli to cutaneous sensitivity. Curve *A* represents the cutaneous sensitivity, and curve *B*, the ocular sensitivity.

COMMENT

In these normal rabbits which were inoculated intra-ocularly by means of an injection of tubercle bacilli into the anterior chamber of one eye, the ocular tuberculosis and its influence on the development of systemic allergy are reduced to their simplest form. There is no systemic tuberculosis to complicate the picture, and the cutaneous reactions to purified protein derivative must be attributed solely to the ocular disease. Primarily, it is interesting that the degree of cutaneous sensitivity in these rabbits is less than that in the rabbits systemically inoculated. The most probable explanation for this is that less tuberculo-protein diffuses out from the scleral envelop than from a tuberculous focus in the groin. The lower degree of cutaneous sensitivity may therefore be a reflection of the lower stimulus. On the other hand, the smaller initial number of bacilli injected into the eye may be the influencing factor. Against this explanation are the facts that there

was apparently a greater propagation of bacilli in the eye and that the second, uninoculated, eye acquired a degree of sensitivity equal to that in the eyes of the systemically infected rabbits. In any event, the inescapable conclusion is that an active tuberculous focus in the eye alone will not evoke a cutaneous sensitivity of any marked degree.

The constant and well marked sensitivity shown by the uninoculated eye is interesting and brings up the question of organotropism, which has been so widely discussed in relation to ocular tuberculosis and sympathetic ophthalmia. This is a point for further investigation.

These studies are on animals without systemic tuberculosis, the only focus being the result of an injection of tubercle bacilli into the eye. This is obviously a highly artificial condition and in no way parallels the picture of ocular tuberculosis in man, in whom the disease occurs almost invariably in association with systemic infection as a result of hematogenous spread. It is therefore impossible to draw any conclusions of clinical importance, for the results reported here may possibly be reversed when the studies are repeated in systemically infected, or immune-allergic, animals. However, it is of more than passing interest to note that when the ocular tuberculous infection is reduced to its simplest form the degree of cutaneous sensitivity, as determined by the intracutaneous Mantoux test, gives not the slightest indication of the degree of ocular sensitivity. It is also interesting that in the three rabbits noted in the second paper of this series, which showed late exacerbations of tuberculous inflammation, there was an increase in the vascular reactivity of the eye to injections of purified protein derivative but no change or increase in the cutaneous reactivity.

CONCLUSIONS

A local tuberculous focus in the eye of an otherwise normal rabbit produces only a low grade cutaneous sensitivity. This cutaneous sensitivity appears the second week after inoculation and is distinctly less than is observed after systemic inoculation.

The second eye acquires a definite sensitivity to purified protein derivative after inoculation of the fellow eye. This appears to be more constant, and possibly of higher degree, than the cutaneous sensitivity.

There is no relation between the cutaneous sensitivity and the sensitivity of the diseased eye in such a rabbit. Cutaneous sensitivity gives no idea of the degree of ocular sensitivity present.

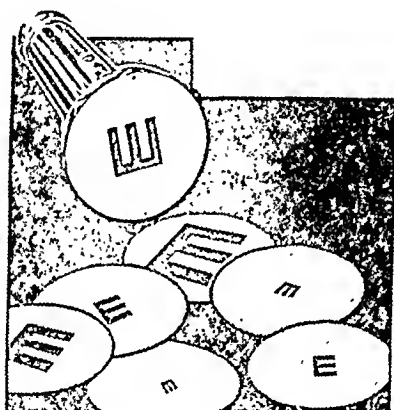
The Mulford Biological Laboratories, Sharp & Dohme, supplied the purified protein derivative used in these tests, and Miss Rosa Himelfarb gave technical assistance.

Clinical Notes

A STANDARDIZED APPARATUS FOR TESTING THE VISUAL ACUITY OF THE PRESCHOOL CHILD

PALMER GOOD, M.D., KENOSHA, WIS.

Increasing demands are being made on oculists and school nurses for the determination of the visual acuity of the preschool child and of the child in the first and second grades. The National Society for the Prevention of Blindness recommends the use of the Snellen E chart for many good reasons, which cannot be explained here, but this chart has the following disadvantages: variability in illumination as it is used in various schools and offices; awkwardness found by the examiner in



Apparatus for testing the visual acuity of the preschool child.

turning from the chart to the child and back again, and inability of many of the younger children to get the idea of change in the direction of the "legs" of the E. A new apparatus was made to retain all the advantages of the Snellen E chart and, in addition, to have the standardized illumination, portability and motion which is required for child psychology and an arrangement such that the examiner can feel the direction of the legs of the E.

The new apparatus has seven interchangeable disks of the 20/15, 20/20, 20/30, 20/40, 20/50, 20/70 and 20/100 sizes, made accurately on washable celluloid to the sizes recommended by Ferree and Rand and transilluminated to give an illumination of 10 foot candles on the surface. The bulb is specially designed to give uniform light, and because of the very low amperage drain on the batteries, it can be used constantly for at least two hours without any variation in the light.

School nurses have reported more rapid and accurate tests in addition to the ability to test the preschool child.

Oculists find it a great help in determining the visual acuity of children and adults with vision of less than 20/50. The usual charts

are easily memorized by such persons and are not made in a sufficient variety of sizes to permit determination of the progress of changes in visual acuity.

With the 20/70 disk it will be found that the distance at which it can be seen is about equal to the distance at which fingers can be counted. The disk, of course, eliminates many of the inaccuracies of the finger-counting test. The vision can then be recorded, for example, as 5/70. The distance from the patient is critical, so that if a patient can just see the direction of the legs of the E at 10 feet (304 cm.), 1 foot (30 cm.) farther prevents recognition. It is the universal visual test because it gives accurate results in the country school, the city school or the oculist's office. It is simple and inexpensive.

Ophthalmologic Review

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OPHTHALMOLOGY IN AVIATION

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In order for a pilot to operate any type of aircraft safely and efficiently, his combined visual elements must function in a manner to insure full visual efficiency without undue nervous or muscular stress. He must be able to regain his senses of equilibrium and position quickly when these are confused after rapid gyrations and while he is in positions to which his body is not accustomed.

In the early days of aviation it was thought that a person in order to fly aircraft must possess a mental and physical equipment that functioned in a peculiarly superefficient manner and that only certain persons possessed such equipments. Later, however, it was found that any person mentally and physically normal could learn to fly more or less successfully. Considering, however, the flying equipment and the general knowledge of aviation, the early flier must have possessed a special brand of psychology to permit him to engage in this vocation.

Early in the World War certain physical standards for fliers were adopted, and all persons assigned to flying duty were required to meet these standards. The standards then adopted have been, with few modifications, maintained to the present day. When the United States Department of Commerce assumed supervisory control of commercial aviation in 1926, physical standards for pilots were adopted similar to those for pilots of the armed forces. The two sets of standards differ in some respects, both as to methods of examination and in actual requirements. However, the physical requirements of both branches of aviation are rigid and are scrupulously maintained.

Ocular stress and dependence on the visual, the vestibular and the muscle sense have been somewhat allayed in recent years by the remarkable advances made in the construction of aircraft and in instruments used in flying. When aviation was in its infancy the flier had little

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to assist him except his inherent physical and mental equipment, the principal factors of which were his eyes, vestibular apparatus and determination. His ship was equipped with little more than a "joy stick" and rudder bar and he with a pair of ill fitting goggles that reduced his field of binocular fixation to a remarkable degree. The cockpit was open, exposing the pilot to wind, cold and noise. In the modern types of aircraft the pilot is assisted by innumerable flying instruments and a comfortable seat, and in the closed ships he is completely shielded from the elements. In the modern open ships, such as the army pursuit types, he is well or completely shielded. Added to these features are the automatic pilots, radio beams, flying beacons and two way radio communication, all of which relieve the pilot of considerable nervous, physical and mental stress, particularly on long flights and in inclement weather.

As the eyes are of the utmost importance in aviation, the routine ocular examination is searching, particularly so when student pilots are examined. All persons are not equally sensitive to ocular defects, either under normal conditions or while under nervous, mental or ocular stress. One person may tolerate, seemingly with full efficiency and without the slightest discomfort, surprisingly large defects, while another under identical conditions cannot tolerate a defect one quarter as large without the greatest discomfort and without impairment of function. Because of this disparity in tolerance it becomes difficult to evaluate the importance of seemingly trivial defects. Therefore it is necessary, in order to reduce to the minimum the number of persons who may become incapacitated later, that a certain high standard be maintained that is applicable to all.

While ocular efficiency is recognized as being essential to the efficient flier, there are exceptions. There is on record one person who, having lost an eye, not only learned to fly with this defect but became remarkably proficient and internationally famous as a pilot. It is reported that an exceptional amount of training was necessary in order to compensate for his ocular defect. The aforementioned record does not, however, lessen the importance of binocular efficiency. To assume that all persons with monocular vision can become safe and proficient pilots is equal to assuming that all persons afflicted as is Miss Helen Keller can equal her achievements.

While the eyes are of the utmost importance, they constitute only a part of the flier's necessary physical equipment. He must be able to coordinate his muscles, nervous responses and visual and vestibular reactions into a smoothly functioning mechanism in order to be a successful and enduring pilot.

The physical standards for pilots of all types of aircraft and for all types of flying are set forth in regulations laid down by the armed

forces of the United States and by the Department of Commerce. All pilots of aircraft, whether military or commercial, are required to undergo a physical examination every six months. The physical requirements vary somewhat with the type of flying the person is authorized to pursue.

The armed forces recognize three classes of fliers, and the Department of Commerce two general classes.

The classes recognized by the armed forces¹ are as follows:

Class 1. Applicants for heavier and lighter than air training and all undergoing flying training.

Class 2. Rated pilots who do not meet the standards of class 1, but whose training and experience, in the opinion of the Chief of the Branch concerned, are such as to compensate for the lower physical standard of this class.

Class 3. Rated observers who do not meet the standards of class 1 may be qualified physically within class 3 provided the physical standards of this class are met, and provided their training and experience, in the opinion of the Chief of the Branch concerned, are such as to compensate for the lowered physical standard of this class.

The classes recognized by the Department of Commerce² are as follows:

The Department of Commerce fliers are classified as commercial and non-commercial. The commercial pilots are classified as student, amateur and private pilots. Besides these main classes of pilots, there are the glider pilots, classified as student, commercial and non-commercial, and lighter than air pilots. Commercial glider and lighter than air pilots are required to pass the same physical tests as are the non-commercial pilots.

While it is required that the eyes function normally in all respects, there are four visual elements that are given especial attention in the examination of all fliers, namely, acuteness of vision, efficiency of the extra-ocular muscles, accuracy in judging distance and discrimination of color. When one or more of these elements are significantly defective the piloting of aircraft becomes a hazardous vocation. In the trained pilot experience may compensate for such inefficiencies, but only to a limited degree. As the efficiency of the aforementioned elements are dependent on and intimately associated with practically all the other elements of vision, color vision excepted, it is necessary that all the elements function in an efficient manner. For this reason the routine examinations cover practically all phases of ocular function.

ACUTENESS OF VISION

As in many other vocations, a high standard of acuteness of vision is necessary in aviation to attain full efficiency in the performance

1. Standards of Physical Examination for Flying, Army Regulations, no. 40-110, Medical Department, United States War Department, 1931.

2. Physical Standards for Air Craft Pilots, United States Department of Commerce, Bureau of Air Commerce, Washington, D. C., Jan. 1, 1936.

of duties to which the person may be assigned. However, in aviation there is an additional importance attached to acuteness of vision. Not only must the flier see objects clearly, but he must be able to locate them accurately as to positions and in their relations to one another. His accuracy in judging distance is dependent, in part, on his acuteness of vision. He must be able to read at a glance his instrument board and finely printed maps, which are located at a distance of about 18 inches (46 cm.) from his eyes. He must be able to determine the character of the terrain when choosing emergency landing fields, i. e., whether or not there are humps, depressions, holes or other obstacles, and these features cannot be recognized quickly and with any degree of accuracy unless vision is acute. The importance of accurate decisions becomes apparent when it is remembered that, flying speed and altitude having been lost, landing frequently must be accomplished regardless of the character of the chosen field. Aside from such factors as those mentioned, there are a multiplicity of conditions and objects that the military pilot must recognize and locate during routine flying and flying on photographic missions, combat details and other duties.

The following visual standards are required by the armed forces:

Class 1. Visual acuity of 20/20 in both eyes without correction.

Class 2. A minimum of 20/30 for each eye.

Class 3. A minimum of 20/40 in either or both eyes provided it can be corrected to 20/20 with glasses for each eye. A visual acuity of 20/50 in either or both eyes may be accepted provided a satisfactory correction is ground in the goggle lenses bringing the vision in each eye to normal and such correction is worn while flying and provided further that such correction does not give an unsatisfactory depth perception.

Near Vision: Accommodation may be considered as within normal limits provided it is not more than 3 diopters below the mean for the examinee's age. For class 1 the examinee will be disqualified if his accommodation falls more than 3 diopters below the mean for his age, but before an examinee is disqualified his accommodation must be taken on three successive days and an average of the three findings taken. Accommodation below 4 diopters disqualifies for class 1 regardless of age. An examinee may be qualified for class 2 if his accommodation falls more than 3 diopters below the mean for his age, provided it is not less than 4 diopters. For classes 2 and 3 examinees are qualified with accommodation below 4 diopters regardless of age, provided they actually wear their correction for near vision while flying, and their correction while worn enables them to read the test card held at 50 cm.

The following visual standards are required by the Department of Commerce:

Transport and limited commercial pilots—20/20 vision or better in each eye separately. Private, amateur and student pilots—20/50 or better in each eye separately. If the vision in either or both eyes is poorer than 20/50 but is brought to 20/30 or better in each eye by glasses, the applicant may be qualified with the restriction that corrective lenses be worn while operating air craft.

Near Vision. Limited commercial and transport pilots should be required to read type 2 D, Jaeger, or its equivalent, or smaller without correction. If the applicant has a vision of less than 20/20, his accommodation may be tested while wearing his glasses or goggles, provided they have his correction in them.

In the armed forces all applicants for training in flying are subjected to a refraction with the use of a cycloplegic in determining the refractive state. The Department of Commerce does not require this as a routine.

An applicant in order to qualify for flying training, must read, with accommodation paralyzed, 20/20 with not more than one diopter of correction in any meridian, whether hyperopic or myopic and not more than 0.50 diopter of cylindrical correction in any meridian. Any candidate with more than 4 prism diopters of esophoria will be disqualified if he has a hyperopia requiring more than 1 diopter of true correction.

While only applicants for training in flying are subjected to refraction as a routine, any flier may be subjected to this examination should it be deemed necessary.

EFFICIENCY OF THE EXTRA-OCULAR MUSCLES AND BINOCULAR SINGLE VISION

Binocular single vision must be maintained while flying, as it must in many other vocations, and it must be maintained in all directions of gaze without undue nervous or muscular stress. The field of binocular fixation is not large when the standard flying goggle is worn. A composite field (fig. 1) constructed from the results of examination of fifty flying cadets³ shows the binocular field of fixation with this goggle to be slightly more than 20 degrees, extending to 30 degrees in the inferior field. It is evident that this field is sufficiently large for safe and efficient flying, as the greater part of the flying performed the last few years has been with this or a similar type of goggle. Furthermore, Friedenwald⁴ has shown that 20 degrees is about the limit of the binocular field utilized by a person under usual circumstances.

Binocular single vision cannot be maintained without ocular stress unless the extra-ocular muscles and fusion control function efficiently. The phoria⁵ is the most common functional defect encountered in the examination of rated and prospective fliers, and reduced power of convergence is the second most common defect.

3. Simpson: Outline of Examination of the Eye, School of Aviation Medicine, Randolph Field, Texas, 1935, p. 30.

4. Friedenwald, J. S.: Diagnosis and Treatment of Anisophoria, Arch. Ophth. **15**:283 (Feb.) 1936.

5. Thorne, F. H.: A Review of Ocular Muscle Imbalance, Mil. Surgeon **66**: 175 (Feb.) 1930.

When binocular single vision is maintained with effort, either conscious or unconscious, and fixation objects are constantly changing, there is likely to be a slight "wandering off" of one eye from the object fixed, the deviation occurring being insufficient to induce pathologic diplopia but sufficient to stimulate areas of the retina not exactly corresponding. This wandering off of one eye alters physiologic diplopia sufficiently to reduce acuteness of depth perception. Maintaining binocular single vision under the conditions just mentioned induces muscular and fusion fatigue, thereby making binocular single vision:

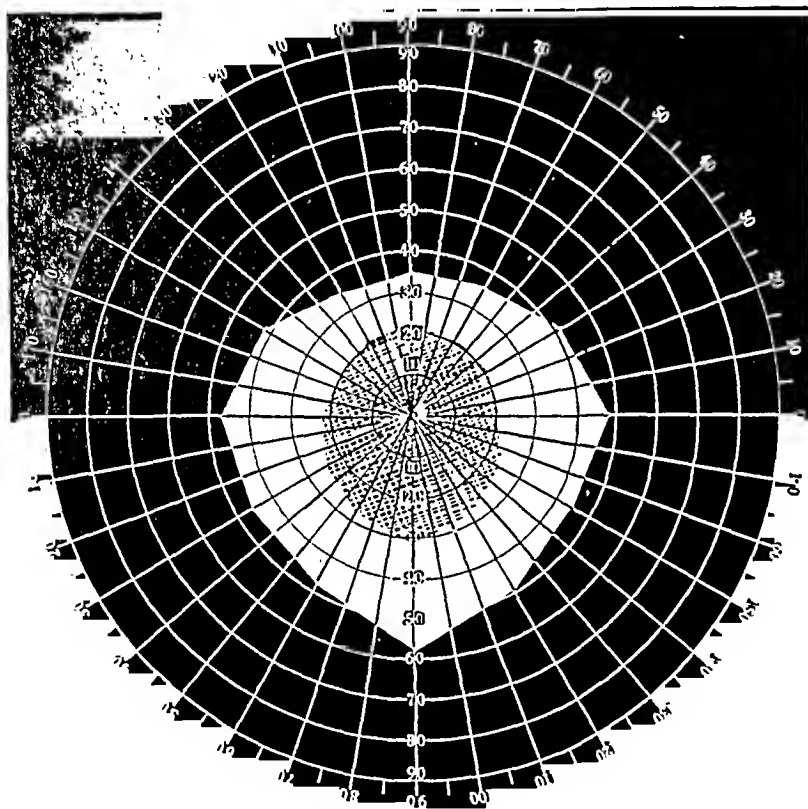


Fig. 1.—Composite field of binocular vision of fifty cadets, showing concentric constriction when a flying goggle (B-6) is worn. The white area shows the normal field, the shaded area, the field when the goggles are worn. Taken from Simpson.³

increasingly difficult. This is particularly true when the person is working under a nervous strain. Furthermore, as a person grows older a latent imbalance may become more and more difficult to tolerate.⁶

Regulations require that the efficiency of the ocular muscles be investigated in all cases. The presence of a phoria, the power of con-

6. Davis, W. T.: Esophoria and Exophoria as a Cause of Obstinate Asthenopia; Cure by Surgical and Other Means, *Arch. Opth.* 10:455 (Oct.) 1933.

vergence (angle of convergence), the power of divergence, associated parallel movements and the presence or absence of diplopia, with fusion abolished, when a phoria above a certain degree has been uncovered, are investigated as a routine.

In the armed forces the horizontal and the vertical muscular balance are investigated with the eyes in the primary position, at 6 meters, and the horizontal muscular balance is tested with the eyes in the same position, at 33 cm. When a phoria above a given degree is uncovered at 6 meters the action of the muscles with the eyes directed in each of the eight cardinal positions is then investigated on the tangent screen, at a distance of 75 cm.

The Department of Commerce investigates the muscular balance with the eyes in the primary position and directed in each of the eight cardinal positions, at 6 meters, as a routine in all cases. Investigations indicate that a phoria occurring with the eyes directed in one or more of the cardinal positions, within 20 degrees, is just as important as a phoria occurring with the eyes directed in the primary position.

The requirements of the armed forces are as follows:

Esophoria of more than 10 prism diopters disqualifies without further consideration. An esophoria of more than 4 prism diopters disqualifies when associated with diplopia on the tangent curtain at 75 centimeters, or when more than 1 diopter of hyperopia of true correction is found.

Exophoria of more than 5 prism diopters disqualifies without further consideration. Exophoria of more than 2 prism diopters disqualifies if associated with an angle of convergence of less than 50 degrees or if associated with diplopia on the tangent curtain. Exophoria of more than 12 prism diopters, at 33 centimeters disqualifies.

Hyperphoria of more than 0.5 prism diopter disqualifies for class 1 without further consideration. Hyperphoria of more than 1 prism diopter disqualifies for class 2 without further consideration. 1.5 prism diopters of hyperphoria is permitted for class 3 provided there is no diplopia on the tangent curtain.

Power of divergence of more than 9 prism diopters disqualifies if associated with an angle of convergence of less than 50 degrees. A prism divergence of more than 15 or less than 4 prism diopters disqualifies for all classes without further evidence.

Associated parallel movements. The under action or over action of any of the extrinsic ocular muscles producing a diplopia, except in the extreme positions, disqualifies for all classes.

An angle of convergence of less than 50 degrees disqualifies for all classes if it is associated with a hyperopia requiring a true correction of more than 1 diopter or if associated with a prism divergence of more than 9 prism diopters. An angle of convergence of less than 40 degrees disqualifies for all three classes.

The qualifications of the Department of Commerce are as follows:

Diplopia test. Diplopia occurring in any position of gaze (red lens before one eye) within 45 degrees disqualifies for any class of license. If correcting lenses are worn the test is made with and without his glasses. If a diplopia disappears with the correcting lenses the examinee is not disqualified for a non-commercial license.

Hyperphoria. A prism diopter of more than 1 disqualifies as a transport or limited commercial pilot. Not used to disqualify for non-commercial grades.

Duction. Abduction (prism divergence) of 3 diopters is required. More than 3 diopters may be accepted, provided the amount of adduction is increased in proportion.

Adduction of 8 prism diopters or more is satisfactory provided there is an abduction of not less than 3 diopters. Duction tests are not used to disqualify for non-commercial grades.

DEPTH PERCEPTION

Depth perception⁷ is an element of vision that must function efficiently if the pilot is to continue flying and retain his health. In importance it must be considered as equal to acuteness of vision. It is this element of vision that enables the flier to level off his ship at the proper distance from the ground when making landings; to take off with the necessary margin of safety over trees, buildings, fences and other obstructions, and to fly in close formations and take part in aerial combat when engagement of enemy ships at close quarters is necessary.

Early in aviation a test of stereoscopic vision, made with an ordinary parlor stereoscope, was considered sufficient to determine whether or not a person possessed ability to judge distance accurately. The aforementioned type of stereoscope utilizes one of the visual elements concerned in the judgment of distance, namely, binocular single vision. Psychic fusion of the two ocular images, which are not identical, is demonstrated by creating an optical illusion, giving rise to an impression of depth where depth does not actually exist. This device, therefore, offers no information regarding actual depth, and it was soon replaced by a device wherein all the inherent or basic elements involved in perception of depth are utilized.

Theory of Depth Perception.—There are many factors involved in depth perception. With some of these factors ophthalmologists are, at least theoretically, familiar, while undoubtedly there are many factors involved of which they are totally ignorant. Some of the known factors constitute a part of the physical and psychic equipment of the individual; they are constant and when considered together may be termed inherent depth perception.⁸ Other factors involved exist outside the body; they are common to all persons; they are variable, and they operate independently of the individual. These factors may be referred to as adjunct factors utilized to enhance the already existing inherent sense.

7. Howard: A Test for the Judgment of Distance, Air Medical Service Information Circular, United States Army, March 15, 1920, pp. 99-115.

8. Thorne, F. H.: A Review of Depth Perception, Mil. Surgeon 63:643 (Nov.) 1928.

The visual elements that go to make inherent depth perception are: (1) acuteness of vision, (2) binocular single vision, (3) physiologic diplopia, (4) binocular parallax, (5) accommodation and (6) convergence.

The adjunct factors that may be utilized are: (1) the size of the retinal image; (2) motion parallax (movements of the head or the object); (3) terrestrial association, consisting of (*a*) linear perspective, (*b*) overlapping of contours and (*c*) light, reflections and shadows; (4) aerial perspective, i. e., the changes with respect to color, brightness and contrast which different objects undergo on account of variations in the clarity of the intervening atmosphere, and (5) experience.

Some of the factors operating to constitute depth perception are common to monocular and binocular single vision alike, while others pertain to binocular single vision only. The factors common to monocular and binocular single vision are: (1) acuteness of vision, (2) the size of the retinal image, (3) accommodation, (4) motion parallax, (5) terrestrial association and (6) aerial perspective. The factors operating with binocular single vision only are: (1) physiologic diplopia, (2) binocular parallax and (3) convergence.

In applying a test to determine a person's accuracy in judging distance it is necessary to utilize only those factors which operate to make for an individual difference in ability, namely, the inherent factors. What a person may gain through experience and that which he may utilize, aside from his inherent equipment, should be left to the subject concerned and to his instructors.

In order to accomplish this the method employed must eliminate all external assistance that experience has taught the subject to employ. For instance, motion parallax is produced either by movements of the person or of objects within his field of vision. For that reason it may be considered as an artificial factor employed to enhance the already existing faculty. It should, therefore, be eliminated as a factor related neither to inherent nor to acquired ability.

External factors which assist all persons equally, such as terrestrial association and aerial perspective, should be eliminated for the same reason.

Factors which normally operate only at a distance of less than 6 meters, such as accommodation, do not need to be considered ordinarily, but accommodation may play an important part when the normal balance between convergence and accommodation does not exist. Fliers are not, as a rule, called on to form judgments at distances of less than 6 meters.

When all external factors and those operating at distances of less than 6 meters are eliminated the following remain to be considered: (1) the size of the retinal image, (2) physiologic diplopia, (3) binocular parallax and (4) convergence.

Size of the Retinal Image.—When dealing with familiar objects the observer knows, through experience, their apparent size. When such objects appear small the observer gains the impression that they are remotely situated in relation to himself, and when they appear larger he has the impression that they are nearer. When one observes two objects that experience teaches are of equal size and one appears smaller than the other the impression is immediately conveyed that the smaller is the more remote of the two, but on this factor alone the actual distance cannot be determined with any degree of accuracy.

Actual tests indicate that in determining distances between objects accuracy is many times greater with two eyes than with one. Deyo⁹ demonstrated that with one eye covered the normal person can distinguish a separation of two posts, one in front of the other, when the average distance apart is 120 mm., but with binocular vision an average distance of 20 mm. can be detected.

In monocular vision binocular parallax, convergence and physiologic diplopia are eliminated. Therefore monocular judgments must depend on the size of the retinal image alone, and such judgments are not particularly accurate.

Since depth perception is many times less accurate when the decision depends on the size of the retinal image alone, it follows that other inherent factors play an important part, and these factors must be physiologic diplopia, binocular parallax and convergence.

Physiologic Diplopia.—The faculty of recognizing differences in distance between objects which are located in space and within one's visual fields is founded, in part, on physiologic diplopia, although a conscious diplopia is suppressed. When the eyes fix an object (binocular fixation) the image of that object falls on the macula of each retina. The two images are fused and projected into space, and one sees the object at the place where the visual lines cross, which is the place actually occupied by the object fixed. The image of another object within the visual fields, located at a greater or lesser distance than the object fixed, falls on the retinas at points outside of the maculae. When the second image falls on the nasal side of the macula of the right eye it is projected to the temporal field, and the image of the object is located to the right of the point actually occupied by the real object and at a distance equal to the distance between its point of contact on the retina and the macula. When the image falls on the temporal side of the macula it is projected to the nasal field and is located in the same manner. The same applies to the left eye. When these retinal points do not correspond, psychic fusion of the two images does not occur, and physiologic

9. Deyo, B. V.: Judgment of Distance: Monocular and Binocular Judgment of Distance, *Am. J. Ophth.* 5:343 (May) 1922.

diplopia results; but when the retinal points correspond, psychic fusion of the two images occurs, and physiologic diplopia does not result. Two objects are located within the field of vision, and but two images are projected. The image or images of the nonfixed object are not to be confused with that of the object fixed. The object fixed appears as one and in its proper position.

Objects located nearer than the object fixed give rise to crossed diplopia, and those more remote than the object fixed give rise to homonymous diplopia. It is because of this crossed and homonymous diplopia that one gains the impression that objects are nearer or farther away, in relation to other objects and oneself. The threshold sensitivity relative to disparate points is very low, about 10 seconds of arc.¹⁰ It may be said, in general, that images falling on disparate points of the retinas, which are located nasally to the corresponding points, give rise to an impression of remoteness, while those falling temporally give rise to an impression of nearness. The greater the disparity the greater will be the distance.

Binocular Parallax.—While one perceives, through physiologic diplopia and the size of the retinal image, the existence of differences in distance between objects and oneself, the binocular parallax augments this perception by giving rise to the impression of relief and solidity.

When one fixes an object the right and the left eye obtain somewhat different views of that object. The right eye sees a little farther around the object to the right, and the left eye a little farther around it to the left. This gives rise to two ocular images that are not exactly alike. When these images are fused in the cerebrum the disparity is responded to by an impression of relief and solidity.

Inherent depth perception, therefore, apparently depends on the following factors: (a) physiologic diplopia, which creates the impression, and suggests the amount, of depth, where depth actually exists, and (b) binocular parallax—psychic fusion of two slightly different ocular images, which gives rise to the impression of relief and solidity, thereby augmenting the impression of depth gained by physiologic diplopia.

Adjunct Factors.—The secondary factors which enhance one's inherent perception of depth, with the exception of motion parallax, exist and operate independently of the person. When utilized they are probably of as much importance as are the inherent factors.

Primarily man is equipped with the basic or inherent factors for forming judgments, and one soon learns, through experience, to utilize all other assistance that comes to hand. However, if these basic factors do not function efficiently, the value of all external assistance that may

10. Ames, A.: Aniseikonia—A Factor in the Functioning of Vision, *Am. J. Ophth.* 18:1014 (Nov.) 1935.

be available is proportionally reduced, because one does not know how to employ it. Because of this it is necessary to determine the degree of efficiency with which the basic factors function.

Equipped with a normal foundation for judging distance, the student soon learns, in his new environment in the air, to utilize all external assistance peculiar to flying.

After one becomes experienced in flying one may be deprived of all the basic factors, with the exception of the size of the retinal image, and still be able to judge distance sufficiently accurately to land a ship. This is particularly true when one is familiar with the ship, the terrain and other factors. This fact has been demonstrated with experienced fliers who have been deprived of the use of one eye temporarily. At first some difficulty is experienced, but this is soon overcome to a great extent. Their ability to continue flying is due to the fact that flying, landing and other maneuvers have become partially mechanical and sub-conscious, and they have learned from experience how to utilize all external assistance to the utmost. However, these persons never regain the fine precision and sense of sureness in flying that they enjoyed previously.

Measuring the Accuracy of Depth Perception.—When one perceives a difference in distance between objects, one's conception of the amount of difference may be accurate, or it may be decidedly inaccurate. It is, therefore, desirable to determine the degree of accuracy one possesses; this is accomplished by utilizing the binocular parallactic angle (fig. 2).

The depth perception box of Howard (fig. 3), employed to measure the binocular parallactic angle, is designed to utilize principally those factors belonging to the basic group. All external factors, with the exception of the size of the retinal image, which usually operate to assist in judging distances are eliminated. The examinee views two posts of equal size, 64 mm. apart laterally and at unequal distances from him (fig. 4). One post is stationary, while the other can be moved forward or backward by the examinee by means of a cord attached to the movable post. The apparent size of the objects and the subject's physiologic diplopia, his binocular parallax and, in some instances, his convergence tell him that a depth difference exists between the two objects. It is the examinee's task to eliminate this difference, i. e., to place the two posts at equal distances from him. The average accuracy with which this is accomplished determines his inherent degree of ability to judge distance.

Etiology of Defective Depth Perception.—Several factors may operate to render depth perception inaccurate. These factors may operate separately or together, and judgment may be consistently poor, or it may be erratic.

Defective vision reduces the accuracy of depth perception for the simple reason that objects and surfaces are not sharply outlined, and physiologic diplopia is partially or completely abolished, depending on the degree to which vision is reduced. The more vision is reduced the more inaccurate judgments will be. When vision is reduced in one eye only, a status of monocular vision is approached, and monocular judgment is very poor, as decisions are based on the size of the retinal image.

Errors in Refraction.—When hyperopic errors in refraction are exhibited—an error of 1 D., for instance—and the examinee maintains

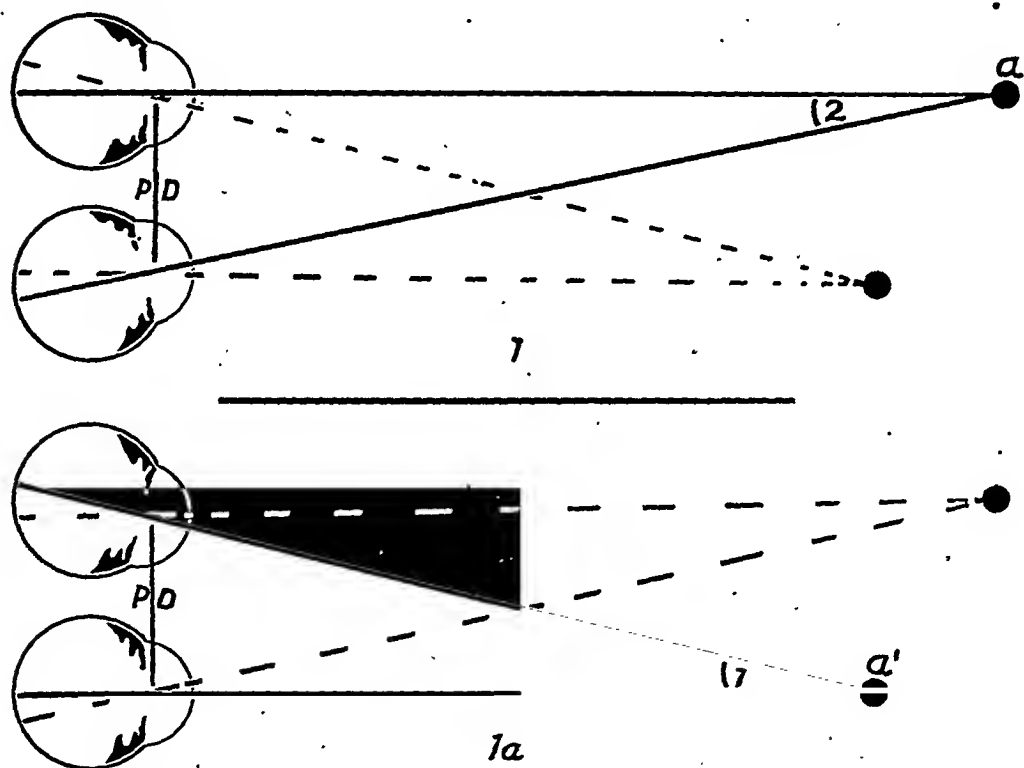


Fig. 2.—Diagrammatic illustration of the binocular parallax angle. The fixation objects a and a' are arranged as in the Howard depth perception box. 1 shows the eyes fixing the far object a . The visual lines crossing at this object form the angle 2 . $1a$ shows the visual lines fixing the near object a' . The lines crossing at this object form the angle 1 . Angle 1 minus angle 2 equals the difference in depth, or the binocular parallax angle. PD indicates the interpupillary distance.

visual acuity of 20/20, he is doing so by accommodating 1 D. in excess of the normal. He is, however, at the same time converging only the normal amount for the distance fixed, which is nearly nil for infinity. This state introduces an imbalance between convergence and accommodation. When the eyes have to accommodate 1 D. to maintain vision of 20/20 they should, at the same time, converge 1 meter angle in order

to effect a balance between these two factors. If a balance were attained under the conditions just described, the image would be out of focus, as the visual lines would cross at a distance of 1 meter instead of at the point in space occupied by the object. Therefore, in order to converge and accommodate accurately in fixing the object the lateral rectus muscles must exert sufficient pull to offset the natural urge to converge. The excess of nervous energy expended in maintaining this imbalance is interpreted, psychologically, into distance, and objects within the visual field will appear at a greater or lesser distance as the case may be. Even

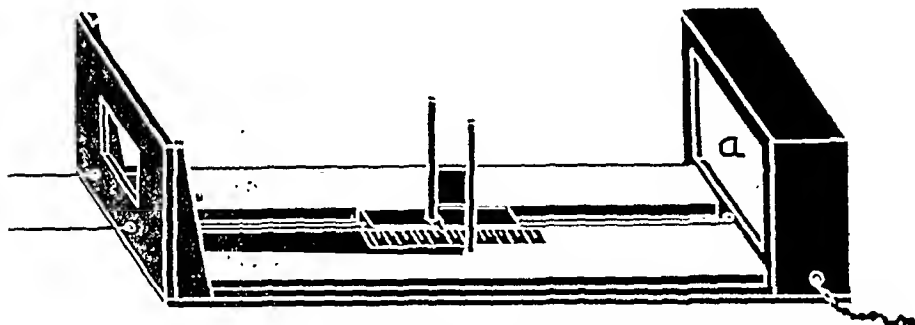


Fig. 3.—The Howard depth perception box with posterior illumination. The bulb in the cabinet (a) should give illumination equal to 8 foot candles at the stationary post.



Fig. 4.—The test objects of the Howard depth perception box as seen by the examinee at a distance of 6 meters.

the fixed object may be inaccurately placed. A similar psychic impression is gained in gazing at vertical and horizontal stripes. Clothing with vertical stripes makes the wearer appear taller, while that with horizontal stripes makes him appear shorter—a greater amount of nervous energy being expended in vertical than in horizontal rotation of the eyes.

In the myope this imbalance is not so marked, because there is no accommodation for distance, and the convergence required to cross the visual lines at an object located in infinity cannot be great.

Imbalance of Ocular Muscles.—When it becomes necessary to innervate one extrinsic ocular muscle to a greater degree than another in order

to maintain binocular single vision, the resulting binocular single vision is not very stable, and the instability is increased by fatigue and relaxation of attention. The "wandering off" of one eye, referred to in the section "Efficiency of the Extra-Ocular Muscles and Binocular Single Vision," permits stimulation of cones in the wavering retina that are not identical with those stimulated in the master eye. This stimulation of disparate cones is not necessarily sufficient to cause pathologic diplopia, but it is sufficient to induce disruption of the physiologic diplopia and to cause some blurring of the object fixed. As the retina is very sensitive in regard to stimulation of disparate points, a slight disparity immediately affects one's ability to interpret distances accurately. Then there is the excess of nervous energy utilized by one or more of the extrinsic ocular muscles in maintaining parallel visual lines. This excess of nerve energy is interpreted into distance, as it is in reference to accommodation and convergence.

*Asymmetry of the Ocular Images*¹⁰.—Normally the two ocular images are of equal size and, other things being equal, can be fused by the cerebral centers into one image giving the impression of relief and solidity. However, it has been shown that equality of the ocular images does not always exist and that they may be of unequal size or vary as to shape or both. Asymmetry may range from aniseikonia of the least measurable amount (0.25 per cent) to the manifest type encountered in unilateral aphakia (35 per cent). In squint, anisometropia and other disorders the difference in size ranges from 5 to 15 per cent. Ocular images with a difference in size or shape up to 5 per cent can be fused, but any difference above 1 per cent is likely to cause symptoms. When the asymmetry is over 5 per cent, binocular single vision does not occur, and one image is superimposed on the other, or there is diplopia. It has been demonstrated many times that a person with unilateral aphakia and vision corrected to 20/20 bilaterally cannot judge distance sufficiently well to pass the depth perception test of Howard. Ames¹⁰ has demonstrated, with his tilting field device, that a person with a low percentage of aniseikonia cannot level the tilting field until his aniseikonia has been corrected. When aniseikonia exists accurate binocular single vision cannot be attained, because exactly corresponding points of the retina are not stimulated. Aniseikonia, therefore, reduces the accuracy of depth perception because neither binocular parallax nor physiologic diplopia function accurately, and these two factors are important visual elements concerned in depth perception.

The factors involved in the test with the tilting field device differ somewhat from those involved in the test with the Howard depth perception box. In the test with the tilting field the observer sees only the field with one eye, while with the other he sees the field and the

frame surrounding it. In the test with the depth perception box of Howard the observer sees the same objects with each eye, namely, the screen with its aperture and two vertical posts.

The requirements of the armed forces are as follows:

For class 1, a depth perception of not more than 25 millimeters (9.119 seconds of arc) disqualifies. For class 2 and for class 3, a depth perception of more than 30 millimeters disqualifies. A rated observer examined for class 3, if he wears correcting glasses or goggles while flying, must have his depth perception tested both with and without his glasses or goggles because corrective lenses not infrequently interfere with depth perception.

The Department of Commerce has established the following qualifications:

A depth perception of not more than 30 millimeters, without correcting glasses, on the average of all trials is required for all classes of pilots with the sole exception of certain private, amateur or student pilots as described herein. If the average is more than 30 millimeters without glasses but is not more than 30 millimeters with glasses, applicants for, or holders of, private, amateur or student license may be qualified with the restriction that correcting lenses be worn while operating air-craft.

COLOR VISION

Accurate and rapid discrimination of colors becomes important to the flier when selecting emergency landing fields, recognizing colored signal lights, navigation lights, lights denoting the limits of landing fields, and daylight panels, and in reading colored maps. In selecting landing fields the character of the terrain may be determined to an important degree by its color. The color presented enables the flier to determine whether the selected field is dry, swampy, newly plowed or covered with stubble and many other facts of importance. The rapid and accurate recognition of colors attains its maximum efficiency in the hexachromic person. A person to whom the spectrum appears to contain less than six bands or in whom one or more of the bands deviate from the normal cannot be relied on under all circumstances, as is necessary in aviation.

An aviator may be defective in his discrimination of colors and fly with comparative safety so long as he is flying over terrain and in and out of fields with which he is familiar. However, when he enters unfamiliar territory, when ground panels, colored signals and other devices are resorted to, he is likely to fall into grave difficulties. Therefore, it cannot be considered safe for a pilot with defective color vision to assume responsibility for aircraft flight, because emergencies frequently arise, and pilots may be called upon at any time to fly over unfamiliar terrain, in and out of strange landing fields and in rain and fog.

To determine accurately the type of color defective with which one is dealing is a slow and tedious undertaking. In the Army Air Corps, when physical examinations of candidates are made this invariably means that large numbers are to be examined and the examinations are to be completed in a short period. Consequently, the time allotted to each candidate must be brief.

The notation "color ignorant" or a similar statement, appearing in a report of examination, indicates that the examinee is invariably defective in perception of colors and the examiner unfamiliar with the subject of color vision. Any person possessing sufficient intelligence to be authorized to appear before an examining board is never ignorant of the colors red and green unless his perception of colors is defective. An examinee may be stumped if asked to select such colors as mauve and cerise, but such colors are not employed in the standard tests. In the properly conducted test colors are not referred to by name in any case.

In order for an examiner to investigate and report intelligently on a person with defective color sense he should possess some knowledge of colors; he should know the theoretical content of the spectrum, characteristic of the various types of color defectives, and by the examinee's selection of colors he should be able to classify him accordingly.

In the army considerable difficulty has been experienced in determining and reporting in just what respect examinees are defective in their discrimination of colors. Embarrassing situations have developed in reporting candidates for the Army Air Corps and the West Point Military Academy as possessing normal color vision who were definitely defective and, again, those who were normal as being defective. Sometimes these errors are made because the examiner is unfamiliar with the theories of defective color vision and why certain confusions are exhibited in matching colors, because of insufficient time in which to conduct the test or, not infrequently, because the candidate has memorized the test plates. In order to alleviate this troublesome phase of physical examination Cooley and Grow¹¹ published an outline of the evolution of color vision, the types of defectives encountered, the confusions exhibited by the various types in matching colors and the reasons therefor. This work is based on the Edridge-Green theory of the evolution of the color sense and classification of defectives. The classification and the reactions exhibited by the different types are explained, and if these factors are kept in mind by the examiner a reliable solution of the problem is available. This method at least meets the urgent needs of the Army, as it offers a uniformity in respect to the diagnosis of defective color vision that has not heretofore existed.

11. Cooley, E. E., and Grow, M. C.: Color Vision, Army M. Bull., January 1936, no. 34, pp. 1-31.

A brief outline of the theory of the evolution of color vision and the types of defectives encountered follows:

Color vision is a psychophysical process, the physical component being the light waves that go to form the visible solar spectrum, and the psychic component the sensations aroused by the action of these waves on the sensory organ of vision. As one is dealing with a person's sensations, the determination of the content of the spectrum as seen by color defectives and any method of classification must be theoretical, in part, at least, as it is impossible to illustrate in a concrete manner another's sensations.

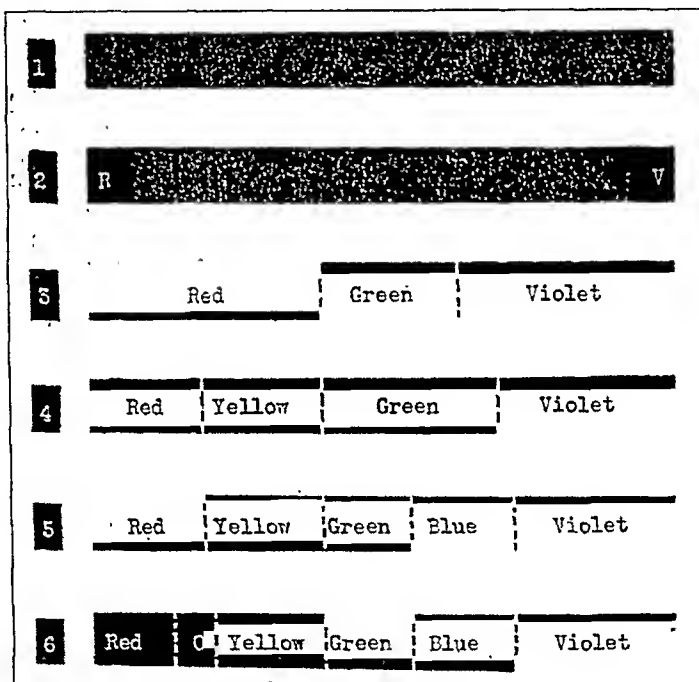


Fig. 5.—Chart illustrating the theoretical evolution of color vision. 1 represents achromism, or the state of the primitive eye, in which the entire spectrum is black or gray. 2 represents the first stage of color vision, in which there is perception of red at one end of the spectrum and perception of violet at the other end, the remainder of the spectrum being black or gray. 3 represents the second stage, or trichromism, in which there is perception of three colors occupying the entire spectrum. 4 represents the third stage, or tetrachromism, in which there is perception of four colors. 5 represents the fourth stage, or pentachromism, in which there is perception of five colors. 6 represents the fifth stage, or hexachromism, in which there is perception of six colors.

Early in the process of evolution the primitive eye could distinguish light and shade, depending on the intensity of the stimulus (fig. 5, 1). The first stage of color perception was ushered in by the recognition of a tinge of red at the left end of the spectrum and a tinge of violet at the right end, the intervening space being black or gray (fig. 5, 2).

In the second stage color vision had increased until the entire spectrum was composed of three colors, namely, red, green and violet (fig. 5, 3). In the third stage yellow was distinguishable between red and green (fig. 5, 4). In the fourth stage blue was distinguishable between green and violet (fig. 5, 5), and in the fifth stage orange was distinguishable between red and yellow (fig. 5, 6). Occasionally another stage is seen wherein indigo is distinguishable as a distinct color between blue and violet. In these cases the entire spectrum is brightened and the discrimination of colors is very acute.

The solar spectrum, therefore, to the person with a fully developed sense of color discrimination, consists of six bands of color of unequal length, each band merging by fine gradations into the adjacent band or bands. The colors, reading from left to right, are red, orange, yellow, green, blue and violet. The six band, or normal, spectrum, is seen by about 80 per cent of the entire population. The spectrum to the remaining 20 per cent is either composed of less than six bands or one or more of the six bands deviate from the normal in one respect or another. The defect is congenital in about 10 or 12 per cent and acquired in the remainder. However, only about 3 per cent of the population are sufficiently defective in color perception to be of any great significance. As acquired defects are usually manifestations of underlying pathologic processes, they will not be considered in this discussion.

Classification and Detection of Color Defectives.—Congenital defective color vision is atavistic in character, and the reversion may be complete, as in the achromic person, or it may involve certain colors or bands of the spectrum only. Furthermore, the colors for which the subject has defective vision may be involved to varying moderate degrees, or they may be completely obliterated and replaced by others. In any case, the spectrum as seen by the subject forms the basis on which he reacts to the various colors, and a classification is made accordingly. If in all cases of defective color vision the involved bands were completely devoid of color or the normal colors were completely replaced by others, the detection and classification of the subject would be a relatively simple matter. The various classifications of defective color vision are based on the spectrum as seen by the subject and are outlined in the following paragraphs.

Space is insufficient in this review to attempt to cover the numerous responses to colors exhibited by the various defectives. Therefore remarks will be confined to those reactions that may be termed basic.

Hexachromism—Normal Color Vision (fig. 6, 1).—Persons falling into this classification see and respond accurately to the colors of the spectrum. In the examination they are prompt and accurate when

matching colors and reading the Ishihara plates.¹² They do not see figures 5 and 2 in the Ishihara plates 10 and 11, and they cannot trace a continuous line from x to x in plate 16.

Pentachromism (fig. 6, 2).—The pentachromic person is the first type in the reversion to the primitive. This person distinguishes five colors in the spectrum. Orange is not seen, and its area is occupied by red and yellow, red encroaching on this area to a greater extent

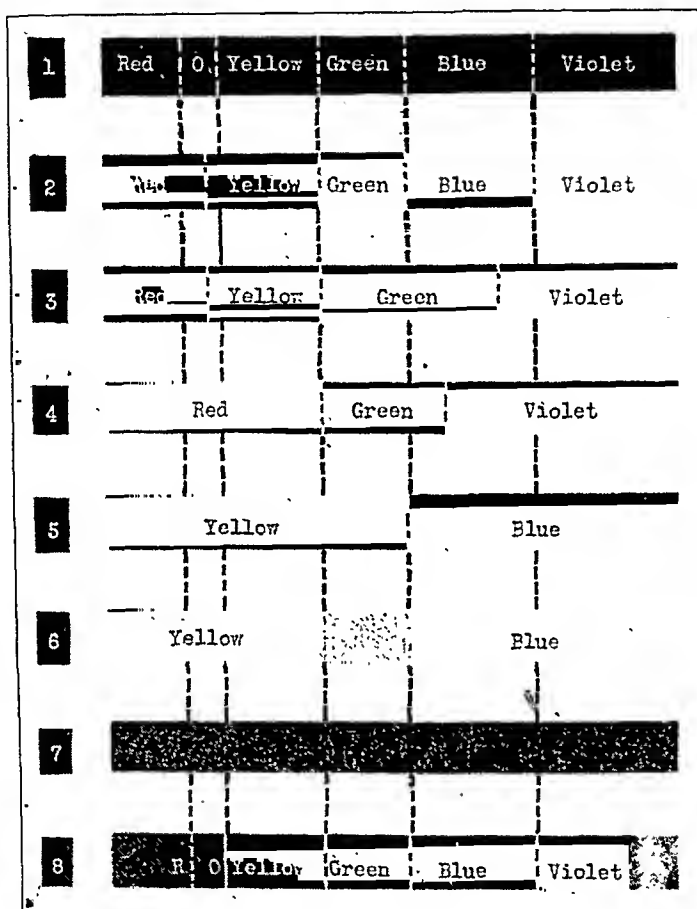


Fig. 6.—Chart illustrating the spectrum as it is seen by persons in the various types of congenital defective color vision (based on Cooley and Grow's paper). 1 represents hexachromism, or normal color vision; 2, pentachromism; 3, tetrachromism, and 4, trichromism. 5 represents dichromism, the ordinary color blindness for red and green most commonly detected in routine examinations. 6 represents dichromism with a neutral band centered in the area occupied by the green band in the normal spectrum. 7 represents achromism, the entire spectrum being gray. 8 represents shortening of both ends of the spectrum; the spectrum is normal otherwise.

than yellow. Orange is recognized as a shade of red or yellow, and brown, being a dark shade of orange, is confused with red or yellow.

12. Ishihara, S.: Tests for Color Blindness, ed. 6, Chicago, C. H. Stoelting Company, 1932.

About 6 per cent of the population belong in this classification. The defect is rarely detected in the routine tests of color vision. In the Army Air Corps many planes, landing tees and wind stocking are painted a shade of orange.

Tetrachromism (fig. 6, 3).—The tetrachromic person sees four colors in the spectrum, orange and blue being lost and that part of the spectrum normally seen as blue being occupied by green and violet. Yellow and red occupy the orange band, as in pentachromism. The green band has encroached on the blue band, and blue is recognized, therefore, as a shade of green. Blue is chosen with green, and brown and orange with red or yellow. About 3 per cent of the population belong in this classification.

Trichromism (fig. 6, 4).—The trichromic person sees three colors in the spectrum. He does not see orange, yellow or blue, and the orange and yellow bands are occupied by the red band. Again, the green band encroaches a good distance on the blue band, but not so far as does the violet band. Yellow, orange and brown are seen as shades of red, and blue is seen as a shade of green or violet. About 1 per cent of the population belong in this class.

Dichromism (fig. 6, 5).—The dichromic person is the type with defective color vision for red and green who is most commonly detected in routine tests for color vision. In this type of defective the spectrum consists of two colors, namely, yellow and blue, and the junction of these is centered in the area normally green. This type of color defect has many variations. Investigations indicate that in one type of dichromism the spectrum consists of green and blue instead of yellow and blue. In the yellow-blue part of the spectrum red, orange and shades of green are recognized as shades of yellow, and violet and shades of green as shades of blue. About 2 per cent of the population belong in this classification.

Achromism (fig. 6, 7).—This type of person is rare. The entire spectrum is devoid of color and appears as black or gray, depending on the illumination. Central vision is poor; intolerance to light may be marked, and nystagmus may be present. This type never appears before aeronautic examining boards because of the manifest ocular defects.

Shortened Spectrum and Neutral Band (fig. 6, 6 to 9).—In addition to the aforementioned deviations from the normal, the spectrum may be shortened at one or both ends, and such defects may encroach a short distance or entirely on the red and violet bands. These areas then appear black or gray. When such an area appears in the body of the spectrum it is referred to as a neutral band and is centered in the green part. Shortening of one or both ends of the spectrum may occur in

any type of spectrum, but a neutral band appears to be found only in dichromism. In this condition a neutral band may expand until it occupies the greater part of the spectrum, only a narrow band of yellow being left at one end and a similar band of blue at the other. A shortened violet end of the spectrum may be of no particular importance, but a shortened red end and a neutral band are serious defects.

A shortened red end of the spectrum is detected when the examinee selects grays with reds. The color red coming from the shortened area of the red band does not exist for the subject. To him that shade of red is gray. The seriousness of this defect becomes apparent in aviation when it is remembered that the most penetrating red rays available, i. e., those rays from the extreme left of the red band, are utilized in red signal lights, and it is this part of the band that is involved in shortening of the spectrum. Red signal lights contain green rays as well as red rays. Consequently, when such a light is viewed through fog or smoke, any of the red rays that may be ordinarily perceptible to this type of defective are obliterated, and only the green rays are visible. Red lights then are recognized as green lights.

According to the theory just stated, a person is actually color blind only at the shortened ends of the spectrum, when a neutral band is present and in achromism. For example, for a person for whom a neutral band occupies the entire green area of the spectrum the color green does not exist. The adjacent colors have not encroached on this area, and it is, therefore, not changed to another color, as in some alterations in the spectrum. This applies to the shortened end or ends of the spectrum as well. Therefore, these areas are achromic and are seen as gray, and the colors normally found in these areas are likewise gray to the subject.

Comment.—Color vision that is normal in all respects is the desirable state. It is doubtful, however, if defective color vision, other than dichromism with and without a neutral band and color vision in which there is a shortened red end of the spectrum, is of paramount importance. Incidentally, dichromism, color vision in which there is a neutral band in the spectrum and that in which there is a short red end of the spectrum are the only types of defective color vision readily detected in routine tests. The Stilling and Ishihara plates are designed to detect, primarily, color blindness for red and green, a neutral band and a short red end of the spectrum. With the complete Holmgren yarn test, if that is properly conducted, the entire spectrum can be investigated, and this is the most efficient test employed. However, this test is time consuming, and its employment as a routine procedure in all examinations, in cases in which large numbers of persons are being investigated, is nearly prohibitive. The Jennings self-recording test is valuable but it lacks the flexibility of the test with the Holmgren skeins.

The approved method of conducting tests of color vision is, briefly, as follows: The examinee is tested with the Ishihara plates. If he reads all the figures correctly and promptly, except figures 5 and 2 in plates 10 and 11, traces a continuous line from *x* to *x* in plates 14 and 15 and fails to trace such a line in plate 16 he is reported as possessing normal color vision. If significant errors are made in reading the figures or in tracing the lines he is then tested with the Holmgren skeins. He is required to match greens, reds and rose under daylight illumination. The number of skeins of each color selected, the errors made, whether he is prompt or hesitant, whether or not selections are made by direct comparison and whether they are changed after such comparison are noted. If, for example, a brown is selected with greens, the brown selected is then used as the test color, and his selections are recorded. Finally, he is asked to select what he considers to be the three brightest colors in the lot. These selections are noted and a statement made as to whether or not the examiner is in accord with these selections.

The requirements of the armed forces are as follows:

If it is apparent that mistakes made by the examinee are due to confusion and not to carelessness or failure to understand instructions, he is disqualified. This standard applies to all classes of examinations.

The Department of Commerce has established the following qualifications:

Ishihara test official. A limited commercial or transport pilot is required to see the dominant colors. If he is deficient in the weaker lines of any or all colors he will not be disqualified. If an applicant should be color blind according to the Ishihara color charts, you should forward a classification of his color vision according to other tests, such as the Holmgren, Jennings, or Williams lantern. Although the test is given for the non-commercial grades, color blindness will not be considered as a disqualifying factor.

REACTION TIME

The reaction time of students of flying has been well investigated during recent years, particularly at the Army School of Aviation Medicine. The average reaction time of the satisfactory student was found to be eighteen hundredths of a second. A student whose reaction time was more than twenty hundredths of a second was considered as questionable flying material, although he was never eliminated as a flier on the basis of this factor alone.

Various types of machines for determining the reaction time have been devised for this work. Stimuli and physical responses to the stimuli have ranged from a single electric light, the response consisting of a single movement of one finger, to a complicated series of electric

lights, the response consisting of coordinated movements of both hands and feet. With some types of machines responses were recorded in hundredths of a second, while with other types group reactions were the basis on which the examinee was rated, i. e., a given number of responses required per minute.

In 1924-1925 measurements of the reaction time were made on two successive classes of students flying, about two hundred and fifty in all. Two series of tests were given. One series required a response consisting of a single movement of one finger, and the second series required a response consisting of a single movement of one finger of either the right or the left hand, depending on the color and position of the stimulus (electric light).

It was demonstrated that a large percentage of students, those with a reaction time longer than twenty-hundredths of a second, were either considered for elimination or were actually eliminated by the flying department because of inability to make proper progress in flying. It was discovered, however, that the record of the reaction time influenced the decision of the board to a considerable degree, thereby nullifying any definite conclusions that may have been drawn as to the value of this factor. Later investigations in this field were well controlled, and a quantity of valuable data were obtained.

Complicated responses are always influenced by experience, while in the simple responses experience plays a negligible part. It seems that, so far as the medical examiner is concerned, the basic or inherent reaction time is all that need be considered. It is the task of the medical examiner to turn over to the flying department students who are mentally and physically normal, while their learning time is a problem for the instructors in flying.

FLYING GOGGLES

For flying in a plane with an open cockpit goggles must be worn. Numerous types have been devised. All types restrict the field of binocular fixation to a marked degree, but if a 20 degree field is maintained in all directions of gaze a serious handicap is not incurred. Lenses are furnished the standard type goggle, in which presbyopic segments are inserted. These segments are so placed that they interfere in no way with distant vision. These have proved to be very satisfactory in reading the instrument board, reading maps while in flight and for similar purposes. Corrections for distant vision have been ground in goggle lenses, but this procedure has not proved as satisfactory as the presbyopic correction. A spectacle frame designed to be worn under the goggle has proved to be satisfactory in many instances.

Many of the modern types of airplanes are constructed with an enclosed cockpit, and the high speed attained with these ships makes-

flying in an open cockpit impossible in any case. Goggles are unnecessary in an enclosed cockpit, and it is reasonable to assume that in the near future the flying goggle will cease to be an item of regular flying equipment.

GENERAL COMMENT

The ocular requirements set by regulations were adopted when flying was in its infancy. These requirements could not be based on experience relative to flying and were, therefore, more or less arbitrary. The requirements represent, however, the limits assumed by ophthalmologists to be those within which ocular efficiency can be maintained under varying conditions.

From a purely scientific standpoint it has never been demonstrated, in aviation, that these limits are justified in all instances. For example, an average error of depth perception of 25 mm. is considered as the limit of safety and by constant use has become a psychologic fact. This limit is, however, based on laboratory tests and not on actual experience in the air. A person with a persistent average error greater than 25 mm. has never been permitted to demonstrate his ability to learn to land and maneuver a plane under all conditions. The same criticism is applicable to many other ocular restrictions. The lack of conclusive proof does not, however, warrant relaxation of the ocular requirements, because the basis on which they are founded are sound. It may be said that the more efficient the ocular equipment of a person the more reliable he will be as a flier and the more enduring will be his flying career.

Correspondence

TREATMENT OF NEUROPARALYTIC KERATITIS BY CLOSURE OF THE LACRIMAL CANALICULI

To the Editor:—In reply to Dr. F. H. Verhoeff's criticism, in the December 1937 issue of the *ARCHIVES* (page 1027), of our paper entitled "Prevention and Treatment of Keratitis Neuroparalytica by Closure of the Lacrimal Canaliculi: Report of a Case" (*ARCH. OPHTH.* 18: 325 [Sept.] 1937), we would say that it appears to us that Dr. Verhoeff has overlooked the fact that our presentation was only a case report; that one case report was never intended to exhaust any subject, and that we still think our comment, "It is comparable to the results described by Beetham after he had closed the ducts in patients with filamentary keratitis," and our correct reference to Beetham's paper could only mean that we gave him full credit for the procedure. While Beetham closed the ducts in the treatment of a series of patients with filamentary keratitis, we did it in but one patient suffering from neuroparalytic keratitis, in whom a dry eye followed section of the posterior root of the fifth cranial nerve by the suboccipital craniotomy approach of Dandy. This was the first time, as far as we know, that the canaliculi had been blocked in a case of neuroparalytic keratitis.

We have been interested for more than ten years in the control of the secretion of tears by the nervous system. The plan we have followed while studying the subject was molded after that described by Parsons (*Roy. London Ophth. Hosp. Rep.* 15: 81 [May] 1902). It consists in the study of tearing in patients with a variety of neurologic lesions, and from our work we have been able to reach no constructive conclusions. We have found, for example, that in patients with tumor of the eighth nerve in whom it was necessary to sacrifice both the seventh and the eighth cranial nerve in order to extirpate the tumor, the secretion of tears varied greatly. We have even found the amount of tears after certain types of stimulation to be twice as great on the side from which the tumor was removed as on the normal side. This is but one of the points that has made us question the part that the greater superficial petrosal nerve plays as a secretory nerve to the lacrimal gland. In the case reported the operation was carried out through the posterior fossa, as advocated by Dandy, and not through the commonly used approach, the temporal fossa, as advocated by Frazier. The patient showed no evidence of damage to the facial nerve after operation, and it is impossible to damage the greater superficial petrosal nerve itself in this approach.

The method we have used for measuring tearing was suggested by Dr. Theodore Erickson, who had used Poth's method of measuring salivary secretion while studying a case of neuralgia of the glossopharyngeal nerve after section of the ninth nerve (Paroxysmal Neuralgia of the Tympanic Branch of the Glossopharyngeal Nerve, *Arch. Neurol. & Psychiat.* 35: 1070 [May] 1936). The method we described was used in the case reported, and it is clearly stated in the communication

that "measurements proved that secretion of tears was present on the involved side, but it was only one sixth of the amount in the left eye." In this patient lacrimal secretion was measured repeatedly by the method we outlined, both before and after closure of the canaliculi and after the use of various stimuli. Had we been unable to prove that lacrimal secretion was present, there would have been no point in closing the ducts to dam back what did not exist.

Neuroparalytic keratitis developed in this case six months after section of the posterior root. The lids were sutured and left closed for seven months. The canaliculi were blocked thirteen months after the operation, when return to normal secretion seemed unlikely. Dr. Verboef's suggestion that the canaliculi might better be tied off instead of permanently closed when tear secretion might possibly be restored seems reasonable to us, particularly because of our knowledge of Dr. Buller's early employment of this procedure in cases of infection of the tear sac (*Montreal M. J.* 31: 189, 1902).

In conclusion, we should like to reiterate our opinion that the greater superficial petrosal nerve and the seventh nerve are not so important as secretory nerves to the lacrimal glands as the literature and textbooks indicate. The case reported by us and the cases of tumor of the eighth nerve in which the seventh nerve was sacrificed, cited in the correspondence, are but two of other observations supporting this opinion.

J. A. MACMILLAN, M.D.,
WILLIAM V. CONE, M.D.,
Montreal, Canada.

News and Notes

UNIVERSITY NOTES

Postgraduate Course in Ophthalmology, Harvard University Medical School.—During May the department of ophthalmology of Harvard University Medical School is conducting an all day, four week graduate course in recent advances in ophthalmology. This course is given at the Massachusetts Eye and Ear Infirmary, the entire staff participating, and is open only to men and women qualified in ophthalmology (and not to beginners). It correlates advances in fundamental science with clinical ophthalmology and affords an opportunity for study of pathologic sections, neuro-ophthalmology, preoperative and postoperative treatment, with visits to the wards, ocular complications in general diseases and physiologic optics as applied to refraction.

Registration can be made through the Assistant Dean, Courses for Graduates, Harvard University Medical School.

Course in Study of Ocular Muscles, the Massachusetts Eye and Ear Infirmary.—If sufficient applications are received by April 1, an all day, two week course in the study of the ocular muscles will be given at the Massachusetts Eye and Ear Infirmary by Dr. A. Bielschowsky and Dr. V. G. Casten from April 18 to 30 inclusive.

Postgraduate Course, Oregon Academy of Ophthalmology and Oto-Laryngology.—The third annual postgraduate course in ophthalmology and otolaryngology under the auspices of the Oregon Academy of Ophthalmology and Oto-Laryngology and the University of Oregon Medical School will be given in Portland, April 3 to 9, 1938.

The course is primarily intended for those in special practice, but the program committee has announced that subjects of practical interest to men in active practice will be given the first consideration.

The guest teachers this year are Dr. A. C. Furstenberg in otolaryngology and Dr. Sanford Gifford in ophthalmology. The mornings will be given to lectures and demonstrations by the guest speakers. The afternoon sessions will be held at the outpatient clinic of the medical school, and in the evenings Dr. Olof Larsell, professor of anatomy, will demonstrate the surgical anatomy of the head and neck. Copies of the program may be secured by writing to Dr. Paul Bailey, 929 Medical-Dental Building, Portland, Ore.

Obituaries

DAVID HARROWER, M.D.

1857-1937

On Aug. 8, 1937, David Harrower died at his home in Worcester, Mass. He was born in Watervliet, N. Y., on June 13, 1857, of Scottish parents, descendants of a Huguenot family of Picardy, France. Soon after his birth, the family moved to Peace Dale, R. I.

Educated in Providence, R. I., principally at the Moses Brown School and Mowry and Goff's English and Classical School, David Harrower entered the Harvard University Medical School, graduating in 1884. The next three years he spent abroad, studying ophthalmology and otolaryngology in Edinburgh, London, Vienna, Berlin and Paris. While in London, he served six months as resident surgeon at the Royal London Ophthalmic Hospital (Moorfields) and attended the Central London Ear, Nose and Throat Hospital.

Returning to the United States, he opened an office in Worcester, Mass., being the first well trained ophthalmologist to settle in the city. One of the first, if not the first, extraction for cataract in central Massachusetts was performed by him.

For fifty-two years he served on the staffs of the Worcester City Hospital and the Memorial Hospital, the last twenty years as a consultant. He was a member of the staff of the St. Vincent Hospital for forty-five years, and for many years was a consultant to the Fairlawn Hospital, the Baldwinsville (Mass.) Hospital Cottages for Children, the Milford (Mass.) Hospital, the Holden (Mass.) District Hospital and the Peterborough (N. H.) Hospital.

He was a member of the Massachusetts Medical Society for fifty-three years; the last thirty-two years he served as a counselor and the last twenty-four years as a member of the Nominating Committee. In 1889 he became a member of the American Ophthalmological Society; later he served on the Council, and in 1926 he was president of the society. He also held membership in the American Otological Society and the New England Ophthalmological Society and was a charter member of the American College of Surgeons.

His private practice was very large, his patients coming from all parts of central Massachusetts and the neighboring states of New Hampshire, Rhode Island and Connecticut. He never hesitated to see any one, and his charitable work was extensive.

He was always an inspiration to younger men, ever ready to lend a helping hand, without the jealous superiority frequently observed in older

practitioners. The high ethics of the old school were always in evidence. He had no time for arrogance, ignorance or sham. An inherent joviality and kindness combined with a large experience and common sense made him a delightful and most satisfactory consultant.

His interest in scientific ophthalmology never waned. Particularly interested in glaucoma, he was one of the first ophthalmologists in the United States to employ Borthen's technic for the treatment of glaucoma by iridotaxis and the first to contribute his observations to ophthalmic literature in the United States.

Popularity in his community was evidenced by a host of loyal friends, and his interest in local affairs was always keen. He never hesitated to praise when praise was due. He was a member of the Worcester Club, the Tatnuck Country Club and the Harvard Club of Worcester and of Boston as well as of several other local clubs and societies.

Surviving him are his widow, the former Mary D. Struthers, to whom he was married in Edinburgh, Scotland, on July 27, 1886, three sons, Norman (of Fitchburg, Mass.), Gordon (of New York) and Francis (of Cornwall, Ontario, Canada), and four grandchildren.

WILLIAM F. HOLZER.

JAMES HENRY ANDREW, M.D.

1874-1937

Dr. James Henry Andrew was born at Cambridge, N. Y., on July 29, 1874, and died at the Brooklyn Hospital on Nov. 26, 1937, after a severe and painful illness. He was buried in Woodland Cemetery, at Cambridge, N. Y. Dr. Andrew's ancestors came from Scotland about 1750 and settled in eastern Pennsylvania.

His father, a Presbyterian minister, who occupied charges in different parts of the country, finally came to Brooklyn, so that Dr. Andrew, though born in Cambridge, lived most of his life in that city. While different members of the Andrew family have occupied many prominent positions in the country's history, Dr. Andrew's father remarked, "If we have not been a princely race, we have been a godly one, which," he added, "is much better." The family was of the stock which has made this country great.

Dr. Andrew graduated from the Polytechnic Collegiate Institute in Brooklyn and later received his medical degree from Bellevue Hospital Medical College, New York, in 1896. After practicing general medicine for nine years, he decided in 1905 to devote himself to the practice of ophthalmology and became associated with Dr. Marple's clinic at the New York Eye and Ear Infirmary. After four years' connection with that institution, he transferred his hospital association to the Brooklyn Eye and Ear Hospital. There he was appointed assistant surgeon and associate surgeon in Dr. Jameson's clinic, where he served until he was appointed to a full surgeons'hip in 1925, a position held by him with distinction until the day of his death.

Dr. Andrew was a member of the American Medical Association, the American College of Surgeons, the American Ophthalmological Society, the American Academy of Ophthalmology and Otolaryngology, the New York Ophthalmological Society, the Medical Society of the County of Kings and the Brooklyn Ophthalmological Society, of which he was a past president. In addition to the surgeons'hip at the Brooklyn Eye and Ear Hospital, he was ophthalmologist to St. John's Hospital, the Bushwick Hospital, the Beth Moses Hospital and the Samaritan Hospital.

Dr. Andrew was a constant attendant at the meetings of his medical societies. He was a good speaker and discussed the papers soundly and with clarity.

While he was an excellent clinician, his great forte was in the operating room. Few ophthalmic surgeons were more dextrous, and when

he operated he would always have a goodly audience. He had a singularly even and lovable disposition which endeared him to his patients and associates. He was tall and though dignified was easily approachable and invariably courteous to those who assisted him in his clinic and who labored with him in the wards.

The word "Andrew" means manly or manlike, and Dr. Andrew fitted the characterization. He was passionately fond of the outdoors and was a keen hunter and angler. Few sportsmen cast a line farther,



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to land more gently and unerringly at the desired spot. Supremely happy were the days he spent with his friends in these pursuits.

Dr. Andrew possessed a heaven-born gift of humor, and his delight was to tell Scotch stories, which he did well. If he could relate these stories and fit them to a Scotch friend, his face would beam with mischievous glee.

Dr. Andrew was a good Christian and a fond and devoted husband and father. His memory remains green on the tablet of our hearts, for "he banked his treasure there," and there it will remain.

P. CHALMERS JAMESON, M.D.

Abstracts from Current Literature

EDITED BY DR. WILLIAM ZENTMAYER

Biochemistry

VITAMIN C IN THE OCULAR TISSUES AND LIQUIDS: ITS RELATION TO THE BIOLOGY OF THE LENS. G. BIETTI, *Boll. d'ocul.* 14: 3 (Jan.) 1935.

Bietti repeated and enlarged on the work of Müller, who showed the presence of a reducing agent in the aqueous, which was much diminished when the lens was removed, and which he considered was vitamin C (cevitamic acid). Using Tillmans' reagent as indicator, he estimated the amount in aqueous from which the protein had been removed by trichloroacetic acid. With this method cevitamic acid was found to be present in the aqueous of the animals tested and in that of man. In herbivorous animals (cattle, sheep, rabbits) and in man ten to fifteen times the amount present in the dog and cat was found. It was reduced 50 to 75 per cent in the second aqueous, which was withdrawn after twenty minutes. In rabbits from which one lens had been removed the amount in the aphakic eye was only one fifth of that in the normal eye. These findings confirmed Müller's opinion that the amount of cevitamic acid in the aqueous depends on the presence of the lens. Bietti examined the lenses of animals and found approximately the same amounts per gram of fresh lens as per cubic centimeter of aqueous. The amounts in the cortex and nucleus of young and old cattle were estimated. In young animals the amount in the cortex was only slightly less than that in the nucleus, while in old animals there was a considerable reduction in the amount present in the nucleus. The amount in the anterior portion of the uvea, vitreous and retina of the beef was from one half to one third of that in the aqueous and lens.

Since Tillmans' reagent is not specific for cevitamic acid, dietary experiments were carried out on guinea-pigs in which a diet free from vitamin C was supplemented by fresh beef aqueous or lens substance. A definite protective effect of both aqueous and lens substance could be shown in these animals, which outlived the controls considerably. The effect was less, however, than that of orange juice containing approximately the same amount of cevitamic acid as calculated by Tillmans' indicator.

Bietti next examined the aqueous and lens of animals with naphthalinic cataract and of patients with various types of cataract. In the naphthalinized animals a marked reduction in cevitamic acid was found which was in general proportionate to the degree of opacity. Of the ten patients a marked reduction of cevitamic acid in the aqueous was shown in all but one, a child with zonular cataract. The vitamin was most reduced in two patients with cataracta nigra and nuclear cataract and in aphakic eyes, less so in intumescent senile and in traumatic cataract. Reduction of the amount in lenses removed at operation was equally marked, especially in cases of sclerotic and black cataract.

The amount in eyes of rabbits submitted to roentgen rays was also reduced. Hence the presence of cevitic acid seems to depend not only on the presence of the lens but on its vitality. Fischer believed that cevitic acid ($C_6H_8O_6$) is formed in the lens by dehydrogenation of a molecule of dextrose in the presence of a hydrogen acceptor (systine). Bietti found that by administering large amounts of orange juice to rabbits the amount of cevitic acid in the blood was almost doubled and likewise that in the aqueous, while that in the lens showed only a slight or no increase. In the dog, however, the amount in the aqueous remained unchanged, and that in the blood showed only a slight and very fleeting increase. Animals with experimental infection of one cornea showed a marked reduction in the cevitic acid of the aqueous, which may indicate an interference with the permeability of the ciliary epithelium to this substance. Bietti believes that dehydrocevitic acid, which is present in the blood stream in amounts equal to that in the aphakic eye, passes through the ciliary processes into the aqueous and that here in the presence of a normal lens it accepts hydrogen to form reduced cevitic acid.

In discussing the possible relations of vitamin C deficiency to cataract, Bietti favors the view that deficiency of cevitic acid in the aqueous is the result rather than the cause of cataractous changes in the lens. He was not able to prevent or influence naphthalinic cataract by administering vitamin C.

S. R. GIFFORD.

Congenital Anomalies

UNILATERAL CONGENITAL ANOPHTHALMOS WITH ORBITOPALPEBRAL CYST. M. ROSENBAUM, *Am. J. Ophth.* 19: 1101 (Dec.) 1936.

Rosenbaum reports a case of congenital anophthalmos of the left eye associated with an orbitopalpebral cyst in which the cyst was removed and examined pathologically. Roentgen examination revealed rudimentary frontal sinuses; the left orbit was smaller than the right, and there were a cataract and irregularity of the optic foramen on the left. The right eye was normal. The author discusses the origin of these defects and states the following conclusion:

"Every idiogenetic malformation has its ontogenetic characteristics, which are inherent in its gametes. It is important to note that such embryonal end result is not pathological, but only differentiated, as a result of arrest of development."

W. S. REESE.

A PREVIOUSLY UNDESCRIBED MALFORMATION OF THE PALPEBRAL FISSURE, CONJUNCTIVA AND CORNEA. G. BIETTI, *Boll. d'ocul.* 13: 1537 (Dec.) 1934.

A baby girl 4 days old was seen who was normal except for the ocular deformities to be described: The eyelids were present, though the upper lids were smaller than normal. They were held widely apart by a fold of skin, with which the upper lid borders were fused directly, while below, under the fold of skin, shallow culdesacs were present. The folds of skin covered the globes except for a small part of each

cornea which was exposed. The corneas were small and xerotic, and the interior of the globes could not be seen through them. Bietti supposes that the adhesion between the lid borders which usually occurs was interfered with in some way, which prevented the normal development of conjunctiva and cornea, the former being largely replaced by skin. Possibly an amniotic band may have been a factor. The relations of this condition with cryptophthalmos and congenital symblepharon are discussed.

S. R. GIFFORD.

Cornea and Sclera

CORNEAL CORPUSCLES IN THE REACTION OF HYPERSENSITIVENESS.

H. D. LAMB. *Am. J. Ophth.* 18: 644 (July) 1935.

Lamb briefly reviews the work of different observers on the action of corneal corpuscles in keratitis. He enumerates his observations, comparing them with those of von Szily, who made the only previous report on the anatomic changes in the cornea from hypersensitiveness.

W. S. REESE.

BILATERAL MESIAL SUPERFICIAL DEFICIENCY OF THE SCLERA.

B. GRAVES. *Brit. J. Ophth.* 21: 534 (Oct.) 1937.

Graves has observed a number of cases of a condition which sometimes, at the first casual glance, suggests that tenotomy of the internal rectus muscle has been performed in the past, owing to a small, sharply defined area where the sclera looks thinned, appearing less white than the surrounding scleral tissue.

With the biomicroscope "the visible definition of the bounding edge varies relatively with the conditions of illumination; and what is, under constant conditions of illumination, interpretable as the absolute or structural definition of the edge may vary in different cases and in different parts of the same case."

W. ZENTMAYER.

THE TECHNIC OF CORNEAL TRANSPLANTATION: THE HERMETIC TREPHINE OF FILATOV AND MARTZINKOVSKIY. V. P. FILATOV, *Sovet. vestnik oftal.* 8: 159, 1936.

This modified trephine (FM-2) prevents injury of the lens without use of Filatov's prophylactic spatula. It is most useful in the treatment of leukoma when the anterior chamber is present. The crown of the trephine is conical so that when it incises the leukoma it closes the hole of the incision hermetically. Besides this there is a hermetic membrane in the canal of the crown 5 or 6 mm. from the cutting edge. When the leukoma is incised the aqueous and incised disk escape to the space provided for it by the membrane instead of to the canal; thus the anterior chamber remains present, and the knife will not touch the lens. The new model has been successfully used in many corneal transplantations. If vitreous appears, one should apply Filatov's retrograde obturator and his spatula. Several drawings illustrate the article.

O. SITCHEVSKA.

Experimental Pathology

THE MECHANISM OF EXPERIMENTAL EXOPHTHALMOS. C. F. CODE and H. E. ESSEX, *Am. J. Ophth.* 18: 1123 (Dec.) 1935.

Code and Essex give the following summary:

"Careful dissections of the orbital contents of dogs have been carried out. The attachments and histologic structure of the conical fascial sheath which encloses the orbital contents (*membrana orbitalis*) have been described.

"Electrical stimulation of the central end of the cut vagosympathetic trunk causes circular contraction of the cone-shaped sheath, with forward movement of the eye. Smooth-muscle fibers are present in the cone-shaped sheath.

"The action and independent contraction of the sheath have been established by the following observations: When a longitudinal incision is made through the superior surface of the cone, vagosympathetic stimulation causes separation of the edges of the incision, with very slight forward movement of the eye. A raised flap of the sheath shortens on vagosympathetic stimulation. Isolated strips of the cone perfused in oxygenated Ringer's solution contract on the addition of ephedrine to the perfusion fluid. When the eye is enucleated and replaced by a rubber balloon, vagosympathetic stimulation causes visible contraction of the cone and a rise of pressure in the balloon.

"The action of the smooth-muscle fibers present in the cone-shaped sheath is such that by their contraction the eye is squeezed out of the orbit.

"The surgical removal of a wedge-shaped strip of the conical sheath (*membrana orbitalis*) produces chronic enophthalmos."

W. S. REESE.

VISUAL FUNCTION AND THE GLYCIDES IN THE OCCIPITAL LOBE OF THE RAT. F. SCULLICA, *Ann. di ottal. e clin. ocul.* 64: 50 (Jan.) 1936.

Previous work is reviewed showing that following intense muscular activity a reduction in the glycodes of the cerebral motor areas is present. Scullica attempted to determine whether the same relation obtains between sensory function and the glycodes of sensory areas.

One group of adult rats were blinded by cauterization and killed after five days, and the content of the occipital lobes in glycodes was compared with that of normal animals of the same age.

A second group of rats 25 days old were similarly blinded but were allowed to live four months before being put to death and examined in the same way.

In the first group the occipital lobes of the blinded animals showed an increase in glycodes over those of the controls amounting to from 29 to 34 per cent. In the group allowed to live four months the opposite results were obtained, a reduction of from 35 to 36 per cent being found in the blinded animals.

Scullica believes that the results in the first group showed a storing of glycodes in the animals recently deprived of the use of vision, while those in the second group showed a loss of these substances due to prolonged lack of the visual function.

S. R. GIFFORD.

General

THE INFLUENCE OF THE VITAMIN-D—CALCIUM-PHOSPHORUS COMPLEX IN THE PRODUCTION OF OCULAR PATHOLOGY. S. N. BLACKBERG and A. A. KNAPP, *Am. J. Ophth.* 20: 405 (April) 1937.

This article does not lend itself to abstracting. The authors think that deficient vitamin D—calcium-phosphorus complex may cause weakening of the cornea or sclera and suggest that it may be causative in myopia. Studies are now being made of patients with myopia and primary corneal ectasia, and encouraging results have been obtained from medication designed to rectify the deficient diet.

W. S. REESE.

THE VISUAL ORGAN IN PROLONGED (FIFTY DAYS) STARVATION. M. Y. FRADKIN and L. D. SHAVIN, *Sovet. vestnik oftal.* 7: 874, 1935.

The subject, mentally alert, married, aged 38, conductor of an orchestra, submitted himself to the experiment because he believed that prolonged hunger causes complete regeneration of the whole organism and because he had seen mild cystitis clear up in one of his previous experiments with hunger. The general physical condition with the exception of the cystitis was good. The eyes were normal. The intraocular tension (Schiotz) was 22 mm. The blood pressure, taken with Bailliant's ophthalmodynamometer, was 70 systolic and 40 diastolic. The dark adaptation (Birch-Hirschfeld adaptometer) was within normal limits.

He refused to take food or water the first four days; thereafter he drank 600 cc. of water daily. Up to the forty-seventh day he worked six hours daily at a book on starvation. He lost 16.1 kg., or 26.52 per cent of his body weight. There was gradual decrease of the systolic and increase of the diastolic blood pressure. The pulse rate decreased to 50 beats per minute and the temperature rose to 35.7 C. (99.9 F.).

The eyes showed the following changes: The retina was pale. The intraocular tension was lowered to 10 mm., probably as a result of loss of water from the tissues and from the vitreous. The arterial pressure was 55 systolic and 40 diastolic. The dark adaptation of the rods was markedly lowered while that of the cones remained unchanged. All the changes in the eyes were similar to those produced by avitaminosis, particularly by insufficiency of vitamin A.

O. SITCHIEVSKA.

Hygiene; Sociology, Education and History

REQUIREMENTS OF GOOD DESK LIGHTING. C. E. FERREE and G. RAND, *Am. J. Ophth.* 20: 286 (March) 1937.

Ferree and Rand give the following summary:

"In this paper the requirements of a good desk lamp are outlined and discussed, and one model constructed as a sample is described.

"A satisfactory desk lamp should embody the following features:

"(1) Adequate intensity of light should be provided, also a means for varying intensity to suit individual needs and different types of work without changing the color and composition of the light or the size, shape, or location of the illuminated area.

"(2) The unit itself should be glareless when used with lamps of either low or high wattage.

"(3) It should be placed at a sufficient height to give a wide field of illumination. This spread of light can be increased by certain provisions in the construction of the unit, such as are described.

"(4) The light should be well diffused and evenly distributed on the plane of work and there should be a well-balanced placement of light and brightness in the field of view. For securing this latter condition, an upward component of light is an important factor in addition to the complete elimination of glare from the lighting unit itself.

"(5) Glare on the work should be reduced to a minimum. Diffusion of light and height of unit above the plane of work are important factors in securing this result. The most effective means for eliminating glare on the work, however, is a suitable provision for varying the placement of light.

"(6) The light should be made to approximate daylight in color and composition. For many eyes, particularly in certain pathologic conditions, this is almost imperative."

W. S. REESE.

Instruments

A CUPOLA PERIMETER: MODIFICATION OF THE CLASSIC PERIMETER.
A. BUJADOUX, *Ann. d'ocul.* 173: 888 (Nov.) 1936.

A modification of the pistol-like perimeter of Magitot is described in which the arc of the perimeter is replaced by a lighted cupola fixed in place, which can be easily maneuvered.

The instrument and its operation are described in detail. There are three illustrations.

S. H. McKEE.

NEW KNIFE FOR MELIORATION. A. P. MARTSINKOVSKIY, *Vestnik oftal.* 10: 641, 1937.

Martsinkovskiy constructed, on Filatov's suggestion, a special knife, FM-2, for the shaving off of the anterior layers of the cornea. It has double sharp edges, so that a strip of cornea can be cut off without the knife being turned. Six drawings illustrate the knife and the method of its use.

O. SITCHEVSKA.

Lens

THE HISTOLOGY OF THE ROENTGEN CATARACT: REPORT OF A CASE.
J. GRZEDZIELSKI, *Klin. Monatsbl. f. Augenh.* 95: 360 (Sept.) 1935.

A man aged 31 received three roentgen irradiations for trichophytia profunda barbae at intervals of one week in February 1930. During exposures of the chin and cheeks the eyes remained unprotected. A resultant so-called ophthalmia electrica disappeared within two weeks. The doses of radiation and the details of their application were not known to the author. Vision decreased in August 1933. Intracapsular extraction of the lenses was done. The results of examination with the slit lamp and the histologic observations are reported.

The slit lamp showed numerous subcapsular opacities arranged around the anterior pole of the lens and radially distributed toward the periphery. Many vacuoles of varying size were present behind the anterior capsule. The nucleus was clear. Subcapsular opacities in the posterior cortex formed a ring-shaped, striped and horizontal-oval cloudiness. The center of this ring contained a few isolated glistening dots; it was so clear as to allow a view of the vitreous. The radial striations extending toward the periphery showed stripes resembling those of the annular opacity. Inspection with the narrow beam showed the inner opacity of the ring well defined by an anteriorly concave line which disappeared toward the periphery in the layer of the subcapsular opacities. Thus a meniscus was formed.

The histologic examination revealed proliferation and degeneration of all anterior and posterior subcapsular layers. The changed areas were well defined from the remaining cortex. The fibers of the lens were edematous and some of them were disintegrated, forming detritus. The posterior subcapsular zone presented the central disk-shaped area which had been observed with the slit lamp. This area was composed of spheroid vacuoles with a faintly staining content. The fibers of the cortex and the nuclei were well preserved. The microscopic changes consisted chiefly in proliferation of the epithelium of the lens.

Such a roentgen cataract originates by proliferation of the cells of the epithelium below the posterior capsule of the lens and by their degeneration at the posterior pole of the lens.

K. L. STOLL.

INTRACAPSULAR EXTRACTION OF CATARACT IN COUNTRY PRACTICE. H. ELSCHNIG, *Klin. Monatsbl. f. Augenh.* 98: 191 (Feb.) 1937.

Elschnig describes in detail the preoperative care of the patient and his own method of operating for intracapsular extraction of cataract. Venesection, with removal of from 100 to 250 cc. of blood, is done one-half hour prior to the operation in cases of general hypertension. The lens is extracted in tumbling fashion by grasping its lower third with the forceps. Two sutures, arranged before the operation, are tied directly after delivery and one or two conjunctival sutures are applied afterward. Sterile air is injected into the anterior chamber with a hypodermic syringe and a blunt tear sac cannula. The air is well tolerated, even if the bubble of air is visible for from five to eight days. Reposition of the iris is not required, and vitreous prolapsed or protruding into the anterior chamber will be pushed back by the air. Deformation of the pupil by atrophy of the iris after prolapse of vitreous never occurred with this method.

K. L. STOLL.

Neurology

UNILATERAL CEREBRAL DOMINANCE AS RELATED TO MIND BLINDNESS: MINIMAL LESION CAPABLE OF CAUSING VISUAL AGNOSIA FOR OBJECTS. J. M. NIELSEN, *Arch. Neurol. & Psychiat.* 38: 108 (July) 1937.

The problem under consideration in this article is whether or not there is cerebral dominance, such as exists for speech and hearing, in

the elaboration of visual perception. Nielsen reviews former statements of opinion as to whether visual agnosia for objects (mind blindness) can be due to a unilateral lesion or must be bilateral.

In selecting cases for providing an answer Nielsen used the following critical rules:

"1. The record of the case as published not only must state that visual agnosia for objects was present but must offer evidence for scrutiny and independent diagnosis.

"2. Only one occipital lobe must have been affected. It is clear that if in any case a unilateral lesion produced visual agnosia, there can be no point in citing cases of bilateral lesion of the occipital lobe.

"3. The lack of recognition of objects must not have been due to general cerebral involvement or enfeeblement.

"4. The agnosia must have been more than transient. If the patient recovered before death or if diaschisis seemed to have been the cause of the syndrome, the case was not included.

"5. The lesion must have been verified."

He abstracts thirteen cases from the literature satisfying these criteria as genuine cases of "mind blindness." On the basis of facts in certain of these cases and in two additional cases of his own he emphasizes how natural handedness does not necessarily correspond with opposite brainedness and that one cannot determine which is the major occipital lobe by either handedness or brainedness, owing to the inconsistencies found. He then discusses the exact localization of the lesions in all the cases and presents the following conclusions, based on careful analysis of the material at hand:

"1. One occipital lobe is dominant over the other for recognition of objects.

"2. The dominant lobe is usually the left, but may be the right, even in right-handed persons.

"3. Within the occipital lobe the cortex of the second and third convolutions represents an area which is essential for the recognition of objects. It is not correct to say that here lie memory pictures, for a large part of the brain is utilized in constructing them, but visual memory pictures cannot be evoked without the function of this area..

"4. Impulses reach this area via the transverse occipital fasciculi of Sachs and Violet from the same side and via the splenium of the corpus callosum from the opposite side.

"5. The so-called negative cases cannot be considered as such merely because the left occipital lobe was destroyed.

"6. Cases of lesions in both occipital lobes do not necessarily disprove the concept presented here. In order to disprove it, the specific fiber tracts or cortical area of the major occipital lobe must have been destroyed without producing visual agnosia for objects."

A note is appended calling attention to an article describing a case in which the splenium of the corpus callosum was severed for removal

of a tumor from the third ventricle, and, as the author's concept would predict, the patient subsequently had visual agnosia for objects in the left field of vision.

R. IRVINE.

Ocular Muscles

THE ROLE OF HETEROPHORIA IN BINOCULAR DISHARMONY, WITH SPECIAL REFERENCE TO AIR PILOTAGE. P. C. LIVINGSTON, *Brit. M. J.* 2: 400 (Aug. 28) 1937.

Livingston classifies heterophoria as inherent and acquired. In his language the inherent type is due to dominant macular reception either without rivalry (in which case symptoms do not arise in later life) or with rivalry (in which case the disorder is a potential source of trouble).

The acquired type may be a primary condition, induced by the circumstances of everyday life, or may be superimposed on the inherent type. The person who has a primarily acquired heterophoria complains of ocular discomfort early in the process because of good binocular vision. When an acquired heterophoria is superimposed on the inherent type the symptoms are proportionate to the binocular vision. In many cases heterophoria is symptomless, owing to a strong inherent tendency. Heterophoria can produce not only intense headaches but also a distinctly pathologic state of mind and may cause referred symptoms in other parts of the body.

Hyperphoria produces the most suffering, because binocular vision is quickly strained above the horizontal plane and subconscious control rapidly gives place to central conscious effort. Exophoria with a weak converging power, ocular rivalry, and cyclophoria are also likely to produce symptoms.

In flying, it is not invariable that the pilot with exophoria stalls his engine and the pilot with esophoria comes down heavily on his wheels. Usually a mixing of the high and low approaches occurs, due to overcorrection or undercorrection at succeeding attempts. Every discovered phoria is not the root cause of flying trouble. Fatigue, the onset of illness, a growing dislike for flying, and neurasthenia must be eliminated. Also, heterophoria may result from prolonged concentrated flying, asthenia, malaria, or an injury to the head.

A symptomless heterophoria is best left untreated. In symptom-producing conditions a complete survey of the patient is advisable. The stereoscope and amblyoscope are of value in treatment. Prisms are a temporary aid in heterophoria following cerebral concussion. After a few months they can be reduced in strength, and after six months training can usually be instituted. For a residual deviation, prisms may be prescribed to correct from one half to two thirds of the total deviation.

Prisms are also of value for relieving an inherent or acquired symptom-producing hyperphoria. Operation and suitable orthoptic training may help these patients. The prism power should be divided suitably (but not necessarily equally) between the two eyes.

W. F. DUGGAN.

Pharmacology

MYDRIATIC ACTION OF CERTAIN SYMPTOMIMETIC SUBSTANCES: EPI-NEPHRINE, EPHEDRINE, PARA-METHYL AMINO-ETHANOL PHENOL TARTRATE AND ORDENIN. A. CASTELLI, *Arch. di ottal.* 42:95 (March-April) 1935.

These four drugs of similar chemical structure were studied with regard to their effect on the pupil, the muscles of accommodation and the intra-ocular tension. As test animals, Castelli chose the dove, which has only striped muscle in the iris without sympathetic innervation, and the rabbit, which has smooth muscle with mixed sympathetic and parasympathetic innervation.

None of the drugs had any effect on the dove's iris whether given by instillation, subconjunctival injection or injection into the anterior chamber. In the rabbit all the drugs, when given by instillation, produced slight mydriasis after one hour. The solutions employed were 1:1,000 epinephrine hydrochloride, 1, 5 and 10 per cent ephedrine, 1 and 2 per cent para-methyl amino-ethanol phenol tartrate and 1 and 5 per cent ordenin. When injected subconjunctivally, all the drugs except ordenin produced mydriasis after five minutes, which became complete in ten minutes and lasted six hours. Ordenin produced no effect. Injection into the anterior chamber produced the same results, the mydriasis being no more marked than after subconjunctival injection. The same effects were produced on enucleated eyes of frogs and in rabbits which had undergone complete sympathectomy thirty days before, the mydriasis being more complete than on the side without sympathectomy. Hence connection with the sympathetic chain is not necessary for the reaction, the drug acting on the neuromuscular endings or on the muscle itself. Clinical experiments showed that pupils only partially dilated with atropine could be further dilated by subconjunctival injection of epinephrine hydrochloride, so that a stimulation of the dilator must be involved, which the author believes is accompanied by relaxation of the sphincter.

A group of patients was treated with all four drugs at various times, employing 1:1,000 solution of epinephrine hydrochloride, 5 per cent ephedrine, 2 per cent para-methyl amino-ethanol phenol tartrate and 5 per cent ordenin. Epinephrine hydrochloride by instillation produced no effect in 147 of 202 persons, and only in 4 of the group was marked mydriasis produced. There was usually, however, a fall in intra-ocular tension of from 3 to 4 mm.; this was greatest one hour after instillation and was proportionate to the ischemia produced but not to the mydriasis. Little or no effect was produced on accommodation. Five per cent ephedrine produced mydriasis in all but 5 of 179 persons; it was slight in 99, moderate in 65 and marked in 10. It was usually maximal after forty-five minutes. The intra-ocular tension was elevated in most persons, usually more than 4 mm. There was no effect on accommodation; there was no sensation of burning, but there was moderate congestion. Two per cent para-methyl amino-ethanol phenol tartrate produced only slight mydriasis in 20 of 94 persons and a slight decrease of tension of about 2.5 mm. Ordenin produced no effect by instillation.

Castelli concludes that 5 per cent ephedrine is the most effective of the sympathomimetic drugs for clinical use in producing mydriasis

by instillation, while 1:1,000 epinephrine hydrochloride, when used subconjunctivally, is very effective. In using ephedrine, 10 drops of 1:1,000 epinephrine hydrochloride is added to 20 cc. of the solution to counteract the congestion produced by ephedrine alone.

S. R. GIFFORD.

Physiology

LATENCY OF CORTICAL AND RETINAL ACTION POTENTIALS INDUCED BY ILLUMINATION OF THE EYE. GING-HSI WANG, *Arch. Neurol. & Psychiat.* 37:772 (April) 1937.

Adding to his previous work on the effect of intensity of light on the latency of action potentials in the visual cortex of the rabbit in response to photic stimulation of the eye, the author now shows that the latency also varies with the rate of increase in intensity of the light used to excite the retina. A cortical potential wave produced by a sudden exposure of the retina to an already lighted lamp had a 50 per cent shorter latency and was larger in size than that produced by lighting a gas-filled lamp. The difference may be attributed to the difference in rate of reaching full intensity, the ultimate intensity being the same in both instances. The author correlates this effect of the rate of increase of intensity of light with his observation that in stimulation with flicker the first flash of light shortens the latent period of the retinal and cortical potential wave elicited by the subsequent flashes. This observation is at variance with results of earlier workers.

R. IRVINE.

Retina and Optic Nerve

A CASE OF TUBERCULOUS PAPILLITIS WITH ANATOMIC FINDINGS. H. D. LAMB, *Am. J. Ophth.* 20:390 (April) 1937.

Lamb gives the following summary of a case in which the condition presented by the patient was diagnosed as tuberculous papillitis:

"In a man 47 years old, a railway brakeman, there occurred a very pronounced swelling of the optic papilla and much cloudiness in the vitreous anteriorly and inferiorly to the optic nerve. Superiorly, the retina contained numerous hemorrhages. No significant process elsewhere in the body could be found as an etiologic factor. Because of increased tension and pain, it became necessary to enucleate the totally blind eye. Anatomically, the greatly thickened papilla was found to be infiltrated with islands of epithelioid cells and a few giant cells, surrounded by small lymphocytes and plasma cells. In the neighboring choroid, an extension of the process from the papilla had produced a single tubercle with an involvement of the adjacent retina."

W. S. REESE.

PARACENTESIS AND ATROPINE IN THE TREATMENT OF OPTIC AND RETINAL ATROPHIES. M. L. FOLK, *Am. J. Ophth.* 20:511 (May) 1937.

Folk gives the following conclusions:

"It is obvious that no definite conclusions can be drawn from this investigation: first, because the number of cases is too small; second,

because the period of observation is too short, and third, because no control group has been observed. However, certain impressions can be obtained even from a small series such as this, and my impressions may be stated as follows: (1) Cases of luetic optic atrophy in the early stages seem to be definitely benefited by the combined treatment of paracenteses and atropine. (2) Fairly advanced cases seem to derive only a slight benefit or at least a stay in the progress of the atrophy. (3) Well-advanced cases show no improvement at all. (4) In retinitis pigmentosa the improvement from the treatment is of only a temporary nature and the atropine has to be often repeated. (This thoroughly agrees with the views of Dr. Vele.) (5) Secondary atrophy following retrobulbar neuritis seems to receive very little benefit, if any, from the treatment. (6) The treatment is simple and harmless.

"This adjuvant in the treatment of optic atrophy is brought to the attention of the ophthalmologists of this country for the sole purpose of stimulating further clinical investigation so that a larger series may be accumulated from which more definite conclusions could be reached. The writer hopes to carry on this work and render a final report in the near future."

W. S. REESE.

VARIATIONS OF THE BLOOD PRESSURE IN THE CENTRAL RETINAL ARTERY IN CHANGES OF THE POSITION OF THE BODY OF HEALTHY PERSONS. A. KAMOGAWA, *Klin. Monatsbl. f. Augenh.* 97:611 (Nov.) 1936.

After an introduction on various methods of measuring the blood pressure and after discussing the bibliography in point, Kamogawa reports the results of his clinical research. The apparatus, the material and his methods of examination are described. Tables show data on the general and the retinal arterial blood pressure of thirty healthy persons in a sitting and in a recumbent position. Immediately after the subjects assumed a horizontal position the measurements were taken by means of the ophthalmodynamometers of Uyemura and Saganuma, and measurements of the brachial artery were made simultaneously. The author found an increase of 11.3 mm. of mercury for the systolic blood pressure and 11.3 mm. for the diastolic blood pressure in the central retinal artery immediately after change from a sitting to a horizontal recumbent position. The causes for this change of the blood pressure are the weight of the blood (and, secondarily, the change of the distribution of the blood in the body) and changes of the tonus of muscles and blood vessels caused by the change of position of the body; other less important causes may occur incidentally. The changes of the blood pressure in the brachial artery produced by the change of the position of the body are outside of standard errors of figuring.

K. L. STOLL.

RETINAL CYSTS AND THE ORIGIN OF HOLES IN THE RETINA: REPORT OF CASES. A. FUCHS, *Klin. Monatsbl. f. Augenh.* 98:145 (Feb.) 1937.

Fuchs reviews briefly the pathogenesis of retinal cysts. There is no distinct anatomic difference, in his opinion, between retinal cysts

and splitting of the retina. He refers to the case of a man aged 23 with von Hippel's disease, in which a cyst was formed by splitting of the retina; histologic data are added. Two cases of retinal cysts are reported, one that of a woman aged 47, and the other that of a man aged 57. In each case the cysts existed for a long time without leading to detachment of the retina. The large cyst disappeared in the first case; therefore, operative procedure need not be hurried in these cases. Fuchs reasons that the cyst formed possibly inward and that this prevented a large detachment; the ophthalmoscopic appearance, however, seems to contradict this conception. He explains why retinal cysts are transparent and as difficult to observe as splitting of the retina. The inner layers of the retina are tightened and thinned by an increased amount of fluid. The tension of the walls of the cyst counteracts the formation of an edema which would produce a whitish or opaque appearance of the retina. The tension produced by the accumulated fluid in the cyst in the first case changed, so that the walls of the cyst grew gradually more transparent and therefore less visible.

The origin and importance of holes in the retina are discussed in the second part. Holes in the retina, in Fuchs' opinion, originate mostly by simultaneous action, and less frequently by separate action, of two factors: (1) traction and changes in the vitreous and (2) degeneration of the retina. There may be other reasons for the occurrence of holes and ruptures of the retina, with following "idiopathic detachment." Formation of cysts must be distinguished from cystoid degeneration. The formation of cysts is characterized by progressive accumulation of fluid which produces a separation of the retina so that its walls become prominent outward and inward. This condition occurs rarely in the extreme periphery. Typical senile cystoid degeneration, on the other hand, begins at the ora serrata and consists in gaps within the tissue. These gaps form as a result of rarefaction of the tissue and passive accumulation of fluid. Fuchs accepts Weve's explanation of the origin of tears in the ora serrata as a result of cysts. On the other hand, he disagrees with Arruga, who refused to accept the theory of distention of the retina as a cause of separation of the retina and choroid, because, Arruga contended, detachment of the retina is rare in young myopic persons, although their eyeballs are greatly elongated. Fuchs points out that the tissues of the eyes of these young persons are far more elastic than those of the eyes of older persons. He reports in detail the case of a woman aged 67 as an illustration of ocular distention. There was a defect in the fovea of each eye. The portion of the retina adjoining the superior temporal retinal artery was greatly rarefied, and the structure of the granular layer had been lost. This paravascular rarefaction, occurring on each side of a vessel and bridged over only by the vessel, is made responsible for the formation of a hole. Senile rigidity of the tissues will further the rarefaction.

K. L. STOLL.

Trachoma

THE RELATIONSHIP BETWEEN CONJUNCTIVITIS AND TRACHOMA. A. F. MACCALLAM, *Brit. J. Ophth.* 20: 346 (June) 1936.

This is the published address of the president at the session of the League against trachoma held in Paris, May 9 to 15, 1936.

MacCallam gives the following definition of trachoma: "Trachoma is a specific contagious disease of the conjunctiva in man. It is chronic in nature. It is characterized by a subepithelial infiltration of the conjunctiva by a cellular exudate, which spreads to the cornea and to the tarsus. It is followed by cicatricial changes in the affected tissues."

He describes the clinical features of the disease, emphasizing the changes which aid in its diagnosis. He states that only in the first stage of trachoma is there difficulty in differentiating this disease from other forms of conjunctivitis. This difficulty is resolved by the detection of cellular infiltration and vascularization of the normally clear cornea at the upper fifth of its circumference.

There are no chemical or microscopic tests which when applied to the conjunctival secretion assist in making a diagnosis; nor would assistance be obtained by removing a portion of the conjunctiva for microscopic examination. In some cases, but not in all, light scraping of the conjunctiva removes some of the superficial cells, which when stained by Giemsa's method exhibit the cellular inclusions described by Halberstaedter and Prowazek; but these are found in conditions other than trachoma, e. g., in swimming-bath conjunctivitis and in the non-gonococcic conjunctivitis of infants; nor can they invariably be detected in the first stage of trachoma; it is quite useless to search for them in the second stage.

The address concludes with an enumeration of the common, uncommon, rare and tropical conditions which on occasion may bear some resemblance to trachoma. It is only necessary to say that in the absence of infiltration of the normally clear cornea by a cellular exudate and in the absence of the vascularization characteristic of trachoma the condition under consideration may be considered nontrachomatous.

W. ZENTMAYER.

Tumors

LEIOMYOMA OF THE IRIS. A. D. FROST, *Am. J. Ophth.* 20: 347 (April) 1937.

Frost discusses leiomyoma of the iris and some of the reported cases. He cites the case of a married woman aged 46 and gives the following summary:

"1. A case which must be regarded as leiomyoma of the iris is described. It is the second case in which the pathologic findings are sufficiently definite to justify this diagnosis. The other case was reported in 1923, by Verhoeff, who reviewed the literature and contributed an excellent description of the pathologic histology of this lesion.

"2. Two cases which have since been reported as leiomyoma by Velhagen and by Bossalino are questionable in that neither of these authors demonstrated the presence of the characteristic myoglia fibrils by differential staining.

"3. Clinically, leiomyoma is relatively benign. Its outstanding pathologic characteristics include a structure of interlacing, closely packed bundles of spindle cells with rod-shaped nuclei in palisade arrangement, displaying eosinophilic cytoplasm and myoglia fibrils."

W. S. REESE.

THE USE OF RADON IN THE TREATMENT OF METASTATIC CARCINOMA OF THE CHOROID. P. JAMESON EVANS, *Brit. J. Ophthalm.* 21: 496 (Sept.) 1937.

The case described is unusual in that metastatic carcinoma, secondary to carcinoma of the breast, developed in each eye, occurring in the one eye two months before it was noted in the other. The first eye was excised, the fellow eye at that time being normal, and the second eye was treated by the application of radon seeds.

The patient was a woman aged 41 whose left breast had been removed two years previous to the appearance of the metastatic growth in the left eye. The eye was removed. The pathologic report on the intra-ocular growth was secondary adenocarcinoma. About five weeks later, vision began to fail in the right eye and quickly fell to 6/60. There was a large, pale, flat detachment of the retina, spreading from the optic disk downward and outward, below the line of the inferior temporal vessels, similar to that seen in the left eye prior to excision. The inferior rectus muscle was secured and cut, the posterior end being retained on a catgut suture. The lower half of the sclera was then exposed. Four radon seeds, having an initial activity of 1.72 millicuries each, were stitched to the sclera; two were placed 12 mm. back from the limbus and 10 mm. apart on each side of the inferior rectus muscle, and two 15 mm. back and 8 mm. apart. A second thread for the purpose of withdrawal was attached to each seed and brought out through the conjunctival wound, while the scleral sutures were brought forward through the lower lid and tied off in pairs, an inner and an outer pair, over rubber tubing.

Two months later, vision was 6/6. The retina was entirely flat, the yellow growth having disappeared, but there was widespread choroidal reaction with pigmentation, which appeared to be spreading in all directions and involved the macular area.

Four months later a fresh patch of new growth was seen adjacent to, and continuous with, the upper and outer margin of the disk. A second application of radon seeds was made. Two months subsequently vision equaled 6/12, and the retina was entirely flat.

The features of interest in this case are, briefly, these:

The occurrence of bilateral metastatic carcinoma of the choroid during a period of three months, two months elapsing between the incidence in the left eye and that in the right eye.

The confirmation of the pathologic changes in the case of the left eye and the exactly similar appearance of the right eye at a later date, which put the diagnosis of the condition of the second eye beyond doubt.

The method of application of radon seeds to the sclera.

The latent period, after the operation, of some two or three weeks before much appreciable change in the appearance of the growth took place; the progressive nature of this change over some two months, and the widespread choroidal reaction, which also was progressive for about the same period.

The complete replacement of the retina on the disappearance of the growth, with full return of the visual field and of visual acuity.

Absence of any sign of recurrence in the eye over a period of seven months.

The application of radon seeds a second time, resulting in disappearance of the tumor.

The gradually increasing glandular character of the metastatic growths as compared with the primary tumor of the breast.

The article is illustrated.

W. ZENTMAYER.

Therapeutics

RED-PALM OIL IN THE TREATMENT OF HUMAN KERATOMALACIA.
W. R. AYKROYD and R. E. WRIGHT, *Indian J. M. Research* 25: 7 (July) 1937.

Aykroyd and Wright determined the vitamin A activity of red palm oil by experimentally producing in rabbits a condition resembling clinical keratomalacia. They cured these characteristic lesions of the eye by giving the rabbits from 0.5 to 2 Gm. of red palm oil. They then carried out a clinical trial, using 10 minims (0.6 cc.) of the original oil in an emulsion as an average dose for children between 5 and 10 years of age, a suitable allowance being made for younger and older patients. This dose was given twice daily. Difficulties are encountered, one of which is the possibility that a beneficial effect in cases of deficiency may result from simply admitting the patient and placing him on a hospital diet. In three instances, however, the authors were enabled to treat and follow up patients suitable for observation, who remained living under the identical domestic conditions in which the syndrome developed. The only change in their daily routine was the addition of emulsion of red palm oil to their diet. In these the improvement was so definite that the investigators concluded that, so far as the strictly limited observation went, the red palm oil alone acted in the same way as cod liver oil had done previously. Most of the patients with keratomalacia treated in the hospital were infants and young children. Cessation of deterioration may be observed within a week, and definite improvement within a fortnight, after the commencement of treatment with the red palm oil. The average vitamin A content of seven samples of cod liver oil tested was about 300 micrograms of vitamin A per gram, while the carotene content of three samples of red palm oil averaged about 500 micrograms per gram. Most of the samples of cod liver oil were obtained by local purchase. One microgram of carotene and 1 microgram of vitamin A, as estimated by De's method, are roughly equivalent to 1 and 2.6 international units, respectively.

J. A. M. A. (W. ZENTMAYER.)

TREATMENT OF HERPETIC KERATITIS WITH BUCKY'S RAYS. M. M. BALTIN and Z. M. SEREBRIANY, *Vestnik oftal.* 10: 688, 1937.

Irradiation with Bucky's rays was used for ninety-three patients during a period of one and a half years in Helmholtz' Eye Institute. Fifty-five patients suffered from herpes of the cornea, and twenty-six from dendritic, six from disciform, and six from superficial punctate, keratitis. The ages of the patients varied from 20 to 40 years, and males were predominately affected. The majority of the patients stated

that grippal infection preceded the ocular condition. Trauma of the eye as an immediate cause of herpetic keratitis was noted in only four patients.

The best results were obtained in herpes of the cornea (improvement in 89 per cent of the cases), particularly in those cases in which treatment was started in the early stage of the disease. The advantage of Bucky's rays over the roentgen rays is that they are absorbed by the superficial layers of the cornea and do not penetrate beyond it, and the danger of formation of cataract is therefore eliminated. The technic of the treatment is described in detail. The authors draw the following conclusions:

1. Bucky's rays in a correct dose act favorably in herpetic keratitis. The duration of the treatment is shortened considerably; the irradiation is painless and harmless.
2. The best results are obtained in early cases.
3. In deep keratitis the treatment does not produce the desirable effect.
4. In cases of recurrence repeated treatments can be given, as there is no accumulative action on the tissues of the eye.
5. The simple technic of the irradiation makes its use available in dispensaries as a routine treatment.

O. SITCHEVSKA.

Society Transactions

EDITED BY W. L. BENEDICT

AMERICAN MEDICAL ASSOCIATION, SECTION ON OPHTHALMOLOGY

WILLIAM L. BENEDICT, M.D., Rochester, Minn., *Chairman*

Eighty-Eighth Annual Meeting, Atlantic City, N. J., June 7-11, 1937

PARKER HEATH, M.D., Detroit, *Secretary*

ANGIOID STREAKS IN THE FUNDUS OCULI. DR. WILLIAM L. BENEDICT,
Rochester, Minn.

The condition now known as angioid streaks in the fundus of the eye was first recorded by Robert W. Dayne in 1889. Three years later Plange reported a condition, which he thought had not previously been described, which "bore a certain similarity to the disease known as retinitis striata but in etiology resembled retinitis proliferans." He noted a disposition to pigment in striae in the retina after hemorrhage, followed by changes, probably hyperplastic, in the supporting fibers of Müller. At the time Plange's report appeared, H. Knapp published a drawing of a condition similar to that described by Plange. Knapp did not discuss the changes extravasated blood may undergo in the retina but called attention to a "second case of the rare and puzzling formation of dark angioid streaks which Dr. Plange has described." Thus the name by which this condition has since become known was suggested by the conception that the dark radiating streaks were due to extravasated blood.

Many case reports published during the next thirty-six years gave valuable information regarding the nature of angioid streaks and their association with pathologic changes in the choroid and hemorrhages in the retina. A few cases were described in which hemorrhages were not found on repeated examination. I have frequently examined one patient who has been under observation for eight years and have never seen hemorrhages in the fundi. The streaks are always accompanied by choroidal changes of significant extent, although visual acuity may not be seriously impaired unless the macular region is involved. Angioid streaks have not been observed in children, and they are almost always bilateral. Explanations of angioid streaks have been offered by various authors, and while these explanations have been influenced somewhat by their own ophthalmoscopic observation, they have been based primarily on the views of previous writers. As the disease does not necessitate enucleation of the eye, pathologic examinations have not been made in undoubted cases. Conceptions of the histologic picture of angioid streaks have therefore been constructed from the ophthalmoscopic appearance of the fundi, the course of the disease, the effects on vision and constitutional disturbances. Pathologic changes in the choroid have been noted in nearly all reports of cases of angioid streaks of the fundus

oculi. These changes are extensive in many cases and are associated with hemorrhages in the choroid and the retina. The fact that angioid streaks appear in eyes in which hemorrhages are not seen at the time of examination does not prove that the streaks can be formed without hemorrhage. On the other hand, there is as yet no definite proof that extravascular extravasation of blood has any definite part in the formation of the streaks. In an eye which had been removed for relief of pain due to keratitis and secondary glaucoma, Verhoeff found marked fibrosis of the choroid and many projections or ridges comprising the inner layers of the choroid which were produced by cicatricial contraction of the fibrous tissue which had replaced the deeper layers. He had not seen the fundus before enucleation but noted angioid streaks in the fixed specimen. He thought that the angioid streaks could be explained by the ridges in the fibroid choroid and suggested as a descriptive designation for the condition now known as angioid streaks the term "fibrosis choroideae corrugans."

In September 1936 I enucleated the blind right eye of a patient with absolute glaucoma whose left eye showed typical angioid streaks and who had pseudoxanthoma elasticum of the sides of the neck and in the axillary folds. Because of cloudiness of the cornea, the fundus of the right eye could not be seen with the ophthalmoscope, but typical angioid streaks could be seen and photographed after enucleation and bisection of the globe. Microscopic examination of these sections, however, failed to show any pathologic changes that could be identified as angioid streaks. The retinal structures appeared practically normal, except for numerous small vacuoles resulting from fixation and embedding. The retinal vessels were patent and showed no sclerosis, though the patient had high blood pressure and came from a family afflicted with hypertensive disease. There was no retinal hemorrhage. The choroid showed perivascular lymphocytic infiltration about many of its vessels and heavy deposits of pigment surrounding the vessels and nerves. Sclerosis and obliteration of the choroidal vessels were not seen. The veins were large and thin walled. The arteries were all patent, and their walls were not thickened. The lamina vitrea was regular except for a few small hyaloid nodules. There was some fibrosis of the choroid, but folding or projection of the inner layer of the choroid was not present. There was perivascular lymphocytic infiltration in the episcleral vessels, which was most marked in the anterior sections, and a considerable amount of pigment was noted about the vessels and nerves traversing the sclera. In the sections stained with hematoxylin there was no evidence of an increased calcium content in the choroid or in the lamina vitrea. None of the proffered explanations of angioid streaks could be confirmed by microscopic examination of the sections of the enucleated eye.

THE VISUAL RAVAGES OF TRACHOMA. DR. HARRY S. GRADLE, Chicago, and DR. WALTER DE FRANCOIS, Harrisburg, Ill.

An analysis of the records of 2,713 consecutive cases of trachoma observed in the Southern Illinois Trachoma Clinics was made to determine the damage to vision caused by the disease and the extent of improvement that may be expected to follow adequate treatment. Of

the total number of patients, 17 had anophthalmos from one cause or another; therefore, a total of 5,409 eyes were studied. These eyes were divided into several groups according to visual acuity, as follows:

(a) Those with vision better than 20/50. Of the 5,409 eyes, 2,889, or 53.5 per cent, had visual acuity of better than 20/50.

(b) Those with vision between 20/50 and 20/200. Of the total number of eyes, 1,596, or 29.5 per cent, had visual acuity between 20/50 and 20/200. The reduction in vision was due to trachoma in 653 of that number, or 40.9 per cent. Under treatment, the vision in 250, or 39.8 per cent, improved to better than 20/50.

(c) Those with vision less than 20/200. Of the total number of eyes, 924, or 17 per cent, had vision of less than 20/200. The reduction in vision was due to trachoma in 566, or 61.1 per cent. Under treatment, the vision in 177, or 31.2 per cent, improved to better than 20/200.

In the Trachoma Clinics of Southern Illinois 7.8 per cent of the patients are industrially blind as the result of trachoma and its complications. Of the individual trachomatous eyes, about 30 per cent have a reduction in vision that interferes with satisfactory reading, about two fifths of the reduction being due to trachoma. Of the individual trachomatous eyes, 17 per cent are industrially blind, about three fifths of the reduction being due to trachoma. Vision can be restored to the useful point in from one fourth to one third of the eyes, the percentage varying according to the degree of loss and the length of time it has existed.

DISCUSSION

DR. C. E. RICE, Washington, D. C.: In a study of the case records of 1,600 patients with trachoma who were hospitalized in Missouri, it was found that there were 8.2 blind eyes to each hundred patients. That would figure out slightly more than 4 per cent of the patients blind if the two eyes were always affected to the same degree. Fortunately, that is not always true. Of about 4,000 patients whose case records were studied (not all patients were hospitalized), there were 12.5 per cent with vision of 20/200 or less in the better eye, due to trachoma. Dr. Gradle found 8 per cent of the patients with vision of 20/200 or less because of trachoma. It is of much interest that in Dr. Gradle's study it was found that approximately one fourth of those persons blind because of trachoma could have useful vision restored by proper treatment. The earliest case of severe trachoma I have seen was in a baby of 18 months. Pannus had already involved the greater part of both corneas. In this case, bilateral canthotomy and grattage were done after two months of hospital care. The final result was excellent. This case is cited to illustrate that trachoma can be very severe early in life. Another interesting point is that trachoma can remain unilateral. I have seen 12 patients with unilateral involvement to the extent that one eye of each patient was blind, while the other eye had normal visual acuity and no sign of a previous trachomatous infection.

AN UNCLASSIFIED TYPE OF OPTIC NEURITIS: REPORT OF CASES. DR. GRADY E. CLAY and DR. J. M. BAIRD, Atlanta, Ga.

This paper was published in full, with the discussion, in the November 1937 issue of the ARCHIVES, page 777.

SYPHILIS IN RELATION TO THE PREVENTION OF BLINDNESS. DR. CONRAD BERENS and DR. JACOB A. GOLDBERG, New York.

The case records of approximately 100,000 patients with ocular conditions seen in five clinics and hospitals in New York were studied. The Wassermann reactions were obtained for 2,237 of 5,969 patients whose case records indicated possible syphilitic infection. Reactions were positive for 444.

DISCUSSION

DR. E. V. L. BROWN, Chicago: These records are characterized by the writers of this paper as inadequate and inaccurate. The condition of some 6,000 of the 100,000 patients was diagnosed as syphilitic, but a Wassermann test had been made in less than half. Notes concerning the primary, secondary and tertiary nature of the syphilis present were lacking in 97 per cent of the cases, and a history of syphilis in the patient or his family was lacking in 98 per cent. Examinations of the eyes were likewise often inaccurate and insufficient. Interstitial keratitis was diagnosed in 240 cases, yet the fact that the Wassermann reaction was positive in only 54 per cent of them leads one to suspect that there were actually only about 150 real cases of interstitial keratitis in the group, because Igersheimer gives the Wassermann reaction as positive in 91.9 per cent. The conclusion is hard to escape that the condition in a large number of the cases was incorrectly diagnosed as interstitial keratitis. There is no reason to believe that the rest of the work was any better, and the records cannot by any stretch of the imagination be considered as a contribution to the knowledge of the subject of syphilis in relation to the eye, as given in the title of the paper. This is not the fault of the authors, who apparently recognized this fully and placed a good part of the blame on the lack of funds for social service. Four or five clinics had social service, but it was spread out pretty thin; for although it was supposed to cover matters of attendance, treatment, discharge and reference to other hospitals, to the department of health, to the department of hospitals, to a state hospital or to a private physician to record syphilis as a cause of death, even a single such note was found recorded in only 8 per cent of the cases. In one sentence the authors get at the heart of the matter, for they say that "much of the blame must be borne by the physicians." But they offer no remedy or suggestion of any kind. In my opinion, the reason for poor records is to be found in the widespread failure to recognize the dispensary as the crux, the heart, of the ophthalmic clinic, and the failure of the chief of service and, in particular, the head of the department to spend a minimum of three fourths of his time in the dispensary and secondly to give a good three fourths of the surgical work to attending men of middle rank on the staff. Too often he takes it all himself or gives it to the intern in unnecessary amount. If the competent and hard-working men of the middle rank are properly worked with and rewarded, they will do good work and make good records. If they are not given proper consideration, there will not be good work, good records or any other good activity in the dispensary. The condition is country wide, world wide. Every one knows the London, Paris, Vienna, Chicago and Boston clinics. These facts are certainly not peculiar to ophthalmic work. This paper makes the situation clear.

DR. JOHN GREEN, St. Louis: The authors quote Lewis and Holloway, who believe that serious diseases of the eye develop in from 50 to 75 per cent of syphilitic children. This estimate is, in my opinion, quite accurate. From 1916 to 1919 I made a study of 100 syphilitic children from the pediatric clinic of the Washington University Dispensary and the wards of the St. Louis Children's Hospital. It is believed that these 100 cases fairly represent the types of hereditary syphilis seen in a pediatric service and that the number and kinds of ocular complications are what might be expected in such a group. The clinical diagnosis was confirmed in every case by at least a two plus Wassermann reaction of the blood. Seventy-four of these children presented definite pathologic conditions in one or more of the ocular tissues or some derangement of ocular function. As adequate treatment of syphilitic women will almost certainly result in the birth of healthy babies, the means are at hand to eradicate all syphilitic diseases of the eye in infants and children. By this one means alone the incidence of blindness due to syphilis would be reduced 50 per cent.

To designate a disease of the eye as having a syphilitic origin in every case in which the serologic reaction is positive is a grave mistake, but it is equally reprehensible to neglect to have a Wassermann test of the blood made in certain cases in which the clinical manifestations do not certainly indicate syphilis. It is indeed amazing that with the ocular disease that almost invariably has a syphilitic basis, namely, interstitial keratitis, a positive Wassermann reaction should have been found in only 53.8 per cent of cases. This percentage is so much at variance with the ophthalmologic opinion that, with rare exceptions, interstitial keratitis occurring in children is of syphilitic origin that it points to the neglect of the serologic test in too large a number of cases of this disease.

DR. LOUIS LEHRFELD, Philadelphia: A survey on syphilitic atrophy of the optic nerve has just been completed at the Wills Hospital in Philadelphia. A statistical investigation was made of 600 cases of syphilis affecting the optic nerve during a ten year period. The objective of the survey was to find out what happens to the eyesight of syphilitic patients who already show signs of involvement of the nervous system and to ascertain how effective present methods of treatment might be. The most important conclusion of the survey is that the present day treatment of syphilitic patients having involvement of the optic nerve is entirely unsatisfactory so far as improvement of vision is concerned. The only appreciable difference among the treated and the nontreated patients with syphilis who had degeneration of the optic nerve is that the nontreated patients became blind in five years while the treated patients became blind in eight years. Of a group of 350 patients, 250 were white and 100 Negroes. The preponderance of syphilitic atrophy of the optic nerve among the white patients as compared with the Negroes, in whom syphilis is five times more prevalent, may be a basis for suspecting that present methods of treatment may precipitate early atrophy of the nerve, while those who are lax in receiving treatment, particularly Negroes, are less likely to be affected. There is no doubt in my mind that early treatment of syphilis affecting the ocular structures should be instituted to save sight. There is also no doubt in my mind that the present methods of using arsenicals must.

be revised if the percentage of blindness from syphilitic atrophy of the optic nerve is to be reduced. At the present moment the best method of preventing blindness from syphilis is to prevent the disease itself and not to place full reliance on the treatment of the disease.

TRYPARSAMIDE THERAPY FOR NEUROSYPHILIS AND ATROPHY OF THE OPTIC NERVE. DR. LEO L. MAYER, Chicago.

In a previous report, the results of a year's study on 87 patients under active therapy with tryparsamide were published (Mayer, L. L., and Smith, R. D.: *Illinois M. J.* 65: 258-264 [March] 1934). In the present communication I have included a reconsideration of these 87 patients treated with tryparsamide after a period of five years and, in addition, of all patients with neurosyphilis treated with tryparsamide at the Mandel Clinic of the Michael Reese Hospital and at the Northwestern University Medical School Dispensary since the time the drug was made available. At the Mandel Clinic the records of 28 patients treated with tryparsamide were found. In the group from Northwestern University Medical School there were 71 patients treated with tryparsamide during the five year period. From this study it must be concluded that the hesitancy in the use of tryparsamide, which has become widespread because of reports from certain authorities, does not have a firm base on which to stand.

DISCUSSION

DR. FREDERICK C. CORDES, San Francisco: There can be no doubt that the use of tryparsamide carries a certain danger comparable to that encountered in the use of any powerful drug, including arsphenamine. In just what manner this damage occurs is still unsettled. In considering this problem, two factors should be borne in mind: 1. Certain patients are sensitive to tryparsamide, as they may be to other drugs. 2. At times syphilitic atrophy of the optic nerve has a tendency to progress rapidly without the use of any specific therapy. It is rather generally conceded that in cases in which there is no damage to the optic tract the risk is slight, provided one is alert to the early warning of the subjective symptoms or objective signs. When symptoms appear, one must assume that the patient is sensitive to the drug, and in such cases it must be discontinued or used with a great deal of discretion. The results in this series of cases coincide with my experience that atrophy of the optic nerve in itself is no contraindication to the use of tryparsamide provided the patient is carefully observed for evidence of sensitiveness to the drug.

DR. WALTER I. LILLIE, Philadelphia: The number of cases presented is large, and the period of treatment is of sufficient duration not only to obtain a good clinical conception of the value of tryparsamide as a therapeutic agent but to support my contention as well as the contentions of many others that tryparsamide is not more dangerous from the visual standpoint than other preparations used in the treatment of syphilis of the central nervous system. Proper ocular supervision should be instituted for all persons treated, regardless of the therapeutic agent, as it is a well established fact that syphilis alone may and does cause progressive damage to the optic nerves, with resulting loss of peripheral

or central vision, or both. No one has definitely proved that tryparsamide or any other arsenical is neurotropic.

The type of changes occurring in the visual field before, during or after a proper therapeutic regimen has been instituted are similar to those occurring in untreated persons with syphilis, and as yet no pathognomonic defect in the visual field due to tryparsamide has been demonstrated. I believe, as does Dr. Mayer, that suggestion may play an important part in the production of subjective symptoms, while the organic changes are best explained by a direct syphilitic process in the optic nerves, namely, perineuritis. If tryparsamide is of value in arresting active syphilis of the central nervous system, it should also be of value in arresting active inflammation of the retina, choroid or optic nerve, and the presence of the latter should be no contraindication to its use. I am sure that ophthalmologists are all agreed that an untreated active syphilitic process of either the central nervous system or the visual apparatus has an unfavorable prognosis, so that any antisiphilitic therapeutic agent which will arrest or improve the condition should be used regardless of the pathologic condition existing when the therapeutic regimen is instituted. Reliable statistics prove conclusively that in inadequately treated or untreated syphilis of the central nervous system the occurrence of blindness due to atrophy of the optic nerve is about 35 per cent. The comparison of this percentage to the reported 2 to 10 per cent of blindness occurring during treatment with tryparsamide suggests that tryparsamide is preventing the development of atrophy sufficiently to affect the central visual acuity in about 25 per cent of the cases.

DR. LEO L. MAYER, Chicago: If the pretherapeutic status is not recorded, the progress and final results obtained have little basis for comparison. The plea of Dr. Cordes for the study of more large series of such syphilitic patients certainly has my endorsement. Dr. Lillie has also emphasized the necessity of proper ocular supervision of the neurosyphilitic patient, regardless of the therapeutic agent used. I agree with Dr. Lillie. According to my experience no characteristic defect of the visual field has been noted after treatment with tryparsamide. It is also important to emphasize the fact that perimetry must be included as an important factor in the treatment of neurosyphilis. I wish to add another case to this group, to which Dr. Gifford called my attention before I left Chicago. A patient had come to the clinic at Northwestern University for treatment with tryparsamide, and the visual fields, the fundi and the visual acuity were studied. He received six injections of tryparsamide, and when he returned to the clinic after the sixth injection the visual fields were reduced to 5 degrees of the center in each eye. The visual acuity was not reduced, as there was no central scotoma. I simply wish to add that here is one case in which it seems that there might have been an effect from the drug itself.

OCULAR DISTURBANCES ASSOCIATED WITH EXPERIMENTAL LESIONS OF THE MESENCEPHALIC CENTRAL GRAY MATTER, WITH REFERENCE TO VERTICAL OCULAR MOVEMENTS. DR. ERNEST A. SPIEGEL, Philadelphia, and DR. NORMAN P. SCALA, Washington, D. C.

This paper was published in full, with the discussion, in the October 1937 issue of the ARCHIVES, page 614.

NEAR REACTION OF THE PUPIL IN THE DARK: A QUANTITATIVE STUDY. DR. F. HERBERT HAESSLER, Milwaukee.
This paper was published in full, with the discussion, in the November 1937 issue of the ARCHIVES, page 796.

ACCOMMODATION AND THE AUTONOMIC NERVOUS SYSTEM. DR. DAVID G. COGAN, Boston.
This paper was published in full, with the discussion, in the November 1937 issue of the ARCHIVES, page 739.

LATE RESULTS OF EXTRACTION OF CATARACT. DR. EDWARD JACKSON, Denver.
This paper was published in full, with the discussion, in the September 1937 issue of the ARCHIVES, page 363.

FORMATION OF DRUSEN OF THE LAMINA VITREA. DR. BENJAMIN RONES, Washington, D. C.
This paper was published in full, with the discussion, in the September 1937 issue of the ARCHIVES, page 388.

BLEPHAROPTOSIS. DR. EDMUND B. SPAETH, Philadelphia.

In this paper I have emphasized the pleomorphic demands for surgical treatment of blepharoptosis. With the various structures of muscles available, I feel that the different indications for operation can be grouped into subdivisions for maximum results and further that these indications demand definite surgical procedures.

The utilization of the occipitofrontalis muscle has as its indication a certain inflexible group of conditions; the same applies to the utilization of the levator muscle, these indications being subdivided into those for which operation is performed through the anterior surface of the lid, as with the Everbush technic, and those for which operation is performed through the posterior surface of the lid, as with Blasovic's technic; third, the utilization of the superior rectus muscle has similar positive indications and contraindications.

I feel that as much attention should be directed to the differential diagnosis of ptosis from a surgical standpoint as is now directed to the surgical treatment of glaucoma and cataract.

DR. FERRIS SMITH, Grand Rapids, Mich.: The great majority of cases of blepharoptosis may be easily classified as to causative defect and an appropriate corrective procedure selected. The net of this consideration may be set up as follows: There are two objectives: to obtain function and to produce a cosmetic result, the latter consequent on the former. Lesions resulting from trauma, in which both muscles are paralyzed, require the careful study and skilful management indicated by Dr. Spaeth, while those resulting from lesions of the central nervous system may require similar consideration, or, more frequently, no consideration at all.

DR. DANIEL B. KIRBY, New York: I examine the width of the palpebral fissure in the primary position and then compare it with the

width when the eye is directed upward and again when the eyes are directed downward. I also take pictures of the patient for a photographic report in every case. I examine the length of the fissure, the horizontal and also the marginal length as applied to the lower lid. An ideal case is one of congenital ptosis in which there is partial development of the function of the levator muscle or one of acquired ptosis in which there is a partial remnant of the function of the levator. In these cases the resection procedure as applied to the levator muscle by the conjunctival route is indicated. In cases in which there is complete or almost complete paresis of this muscle with a palpebral fissure which actually narrows when the patient looks up because the lower lid follows the globe in elevation and the upper lid does not, there is a definite indication for the employment of the Motais principle of transplantation of the superior rectus muscle. In cases in which there is complete paralysis of the levator and superior rectus muscle and in addition paralysis of the inferior oblique, the condition is called paralysis of elevation by Dr. Wheeler. The eye is in a position of hypotropia and cannot be used even though the ptosis is corrected. It is necessary to lift both the globe and the eyelid, using the procedure devised by Dr. Wheeler of resection and advancement of the superior rectus muscle and advancement of the inferior oblique over the orbital margin. This will tense the remnants of the muscles even though no muscular action is produced and will elevate the globe. Then the Motais or Parinaud principle may be employed to elevate the lid. Cases of ptosis due to trauma or a new growth require special consideration. This covers the field of ordinary surgical treatment for ptosis and leaves no need for the employment of the frontalis muscle in any case. It is true that the average patient with ptosis will hold back his head, arch his brows and wrinkle his forehead in the effort to get the curtain of the lid above his pupil. This is an undesirable feature of the case and gives the typical curious expression. After the use of the frontalis muscle, this expression is continued. The upper eyelid normally slides back over the convexity of the globe, as does the top of a roller desk. Attachment to the frontalis muscle lifts it in an unnatural, straight, vertical manner.

AMBLYOPIA WITH VASODILATORS. DR. WALTER F. DUGGAN, New York.

The results obtained with acetylcholine roughly parallel those obtained with sodium nitrite, administered intravenously. While improvement was slightly faster in the cases in which acetylcholine was used, it was slightly better in the cases in which sodium nitrite was employed. However, the vision was as a whole more reduced with sodium nitrite than with acetylcholine, so that, all factors being taken into consideration, sodium nitrite seems to be slightly more effective than acetylcholine in the treatment of tobacco amblyopia. This difference is said to be due to the fact that sodium nitrite is destroyed less rapidly than acetylcholine in the body, so that its effect is maintained longer. Since both acetylcholine and sodium nitrite bring about a more rapid return of vision in cases of amblyopia than some of the previously used methods of treatment, this lends further support to the hypothesis that tobacco amblyopia is due primarily to a vascular spasm in the optic pathways.

DISCUSSION

DR. LAWRENCE T. POST, St. Louis: The most important question involved in Dr. Duggan's paper is whether vasodilators are valuable in the treatment of tobacco amblyopia. The author and others have previously discussed the hypothesis that this disease is due to a vascular spasm in the visual pathway and that vasodilators shorten the time of return to normal in these cases, but I think these points are still unproved. Several speculations regarding the possible value of vasodilators in the treatment of tobacco amblyopia occur to me. If it is assumed that the symptoms are produced by a prolonged constriction of the blood supply of the visual apparatus, does it necessarily follow that relief from this constriction, if obtainable, would restore normal function? In diseases involving constriction of the peripheral vascular system of the extremities, though dilatation of the vessels of the extremities can be caused by sodium nitrite or acetylcholine, this does not help the disease condition. But more fundamental than this is the lack of proof that these vasodilators do actually increase the vascular bed of the visual system. There is considerable evidence that they do not dilate the vessels of the retina. Another theoretical point against the likelihood of this therapy being valuable in the treatment of a relatively chronic or at least a nonacute condition is the evanescent action of these vasodilators. At most they probably act only a few moments, and in the author's cases they have been used only once a day. In a previous paper the author, in considering the action of acetylcholine, remarked on the transitory nature of its action and referred to the fact that the action is much prolonged in the presence of physostigmine even in small quantities. One of the authors whom he quotes used physostigmine as a preliminary to acetylcholine. Since it is reasonable to assume that a prolongation of action is desirable, this combination might be useful. In the medical service at Washington University, acetyl-beta-methylcholine has been found to have a much longer action than acetylcholine and is being used in preference to the latter drug. It is suggested that if vasodilators are proved to be valuable in the treatment of tobacco amblyopia, this drug might be found advantageous. The possibility of improvement by vasodilators must be further considered, but other factors that might be important in quick recovery should be carefully sought.

DR. WALTER F. DUGGAN, New York: Since patients have noted that after any period of physical stress their vision seems to decrease, it has been my custom to allow the patients to rest a short time before the vision is tested. With improvement in the vision, there is a definite decrease in the size of the scotoma. Often patients say that their vision is improving, and, while the visual acuity may be the same, the scotoma will be found to be definitely smaller. An analogous case, which I saw with Dr. Knapp, was one of spasm of a branch of the central retinal artery in which the spasm, with a defect in the visual field, had lasted for two months. The spasm suddenly disappeared one night, and the patient came in a few days later with a greatly improved visual field and visual acuity. I know that reports have appeared stating that vasodilators do not dilate the retinal vessels. In the first place, I do not

think the retinal vessels are involved in tobacco amblyopia. Also, if the retinal arteries are of approximately normal size, any slight increase in diameter would not be apparent. I have seen very constricted retinal arteries dilate with this treatment. The vascular bed must be increased, because in 2 or 3 of my cases the intravenous administration of sodium nitrite was followed by a definite fall in blood pressure of from 20 to 40 mm. of mercury, which was maintained for several hours. Acetylcholine acts only a few minutes on the blood pressure. The pressure will drop 10 or 20 mm. and then be back to normal in fifteen or twenty minutes at the most. I think the use of physostigmine before the administration of acetylcholine would help.

IMPORTANCE OF DIET IN THE ETIOLOGY AND TREATMENT OF TOBACCO-ALCOHOL AMBLYOPIA. DR. FRANK D. CARROLL, New York.

This paper was published in full, with the discussion, in the December 1937 issue of the ARCHIVES, page 948.

THE DOMINANT EYE: ITS CLINICAL SIGNIFICANCE. DR. WALTER H. FINK, Minneapolis.

This paper will be published in full, with the discussion, in a later issue of the ARCHIVES.

GERMAN OPHTHALMOLOGICAL SOCIETY

DOZENT DR. M. BÜCKLERS, Tübingen, *Reporter*

Fifty-First Annual Meeting, Heidelberg, July 6-8, 1936

TRANSLATION BY PERCY FRIDENBERG, M.D., New York

Second Scientific Session

Monday, July 6, 1936, 3 p. m.

PROF. W. MEISNER, Cologne, *Chairman*

DISCUSSION ON REPORTS I, II AND III¹

PROF. BRUNO FLEISCHER, Erlangen: The intensive investigation of Dr. Bücklers on hereditary corneal dystrophy, especially his discovery of a form which apparently is transmitted as a recessive character, is welcome. However, as long as an essential differentiation (perhaps of a chemical or a pathogenic nature) has not been demonstrated, the differentiation of certain types of corneal dystrophy which are characterized by definite morphologic aspects or by varying modes of hereditary transmission does not necessitate abandoning a designation

1. This discussion was omitted from the proceedings of the Second Scientific Session published in the September 1937 issue of the Archives (vol. 18, p. 482). It should precede the report by Dr. W. Clausen, of Halle, on "The Role of the Ophthalmologist in the Prevention of Hereditary Diseases."

such as familial corneal degeneration, which, after all, has been introduced generally and which sums up the essential feature of the condition. One does not need to consider it anything more than a deposit of certain pathologic products in the corneal tissues caused by some anomaly of metabolism. Not only the crumbly (*bröckelige*) but the spotty (*fleckige*) type of corneal dystrophy has a dominant heredity, if I remember correctly.

PROF. KARL LINDNER, Vienna: I am definitely opposed to the conception of spontaneous detachment of the retina as a phenomenon of heredity. This process is the result of several partial or cooperating factors, only one of which can be looked on as inherited. In regard to myopia, I hold to my original idea that close work plays an important role in its progress. If one were to consider progressive myopia as a purely hereditary condition, any attempt at therapeutic or hygienic measures might just as well be given up as useless. But, as of old, one's most important duty is still the careful correction of the myopia, and in case it progresses, the limitation of the use of the eyes for close work.

PROF. WALTER LÖHLEIN, Berlin: Do previous experiences in biogenetic research on the eye offer the hope of gaining clues as to whether the degree of manifestations of a given pathologic (hereditary) disposition will be intensified or mitigated in the succeeding generations? Such a knowledge would be of the greatest practical importance, especially in cases in which an actual hereditary blindness is not present but in which the parents require advice in regard to future offspring. This question is raised most persistently when the manifestations of a hereditary ocular lesion vary noticeably in members of the same family. As an example, a family is cited in which the first child was born with normal eyes and a second child had aniridia, nystagmus and bilateral blindness at birth. The mother's eyes were normal. In the father's eyes, however, there was found as the basis for the pathologic (hereditary) disposition a unilateral pit formation (*Grubenbildung*) on the disk, with normal vision and field.

DOZENT DR. MAX BÜCKLERS, Tübingen: I cannot support Professor Fleischer's contention that the old designation of familial corneal degeneration or dystrophy should be retained, for the very reason, if for no other, that formerly a number of quite unrelated or at least differing clinical pictures were classed together as variations of manifestations of one and the same basic form of ocular disease. In the interests of racial and social hygiene alone and of a clear understanding of this aspect of the problem, it is absolutely essential to separate fundamentally the three forms of hereditary corneal dystrophy. Lenz objects, and with good reason, to the use of the term "degeneration" on the ground that it has quite a different significance in biogenetics. In the last analysis, every hereditary disease or anomaly is "familial." One does not speak of familial opacities of the lens. In all the 10 family trees of patients with spotty corneal dystrophy, of which I was able to bring with me only the 2 smallest, a recessive heredity can be demonstrated without a single exception. In 1 family an affected father had several sick children, but this was explained by the fact that he had married a blood relation who was probably a carrier or transmitter.

FRIEDRICH OEHLKERS, Freiburg in Breisgau: The term "mosaic inheritance" which has been used in the course of general remarks on my report has a definite meaning in general biogenetics. It is not used to specify a modification of gene combinations (*Umkombination*) or different manifestations of a biogenetic nature but only to denote highly unstable (*labile*) genes which undergo variations within a single individual.

O. VON VERSCHUER, Frankfort-on-Main: The concept of a sex-linked hereditary transmission has become accepted by regular usage in the science of genetics during the past twenty-five years. A change in this conception cannot well be accomplished. In heredobiology the concept of coupling (*Koppelung*) also has a definite meaning. Those hereditary anlagen are considered as coupled which are located in one and the same chromosome. This concept must be differentiated from that of correlation, by which is understood, to begin with, the purely quantitative relations between two or more events. Correlation may be the result of similar hereditary dispositions or of similar environmental factors. In every instance of correlation this possibility must be borne in mind. Special biogenetic research is essential to determine whether one is dealing with a common or a shared biogenetic basic factor, or, on the other hand, whether there is some other possible explanation for the correlation. To the question as to whether the persistence, energy or intensity (*Durchschlagskraft*) of a hereditary anlage varies or is constant, no definite answer can be given which can be generally and universally valid and hold good in all cases. There are hereditary anlagen which present an extraordinarily constant manifestation through many generations and others that vary in their manifestations. It is impossible, however, to predict whether one is to expect variability or constancy in a given case or whether the manifestation is to be marked or slight. In order to do so, first more accurate knowledge of the biogenetic significance of the hereditary anlagen will be necessary.

J. P. WAARDENBURG, Arnhem, Netherlands: The question of glioma and its biogenetic implications is by no means a simple one. Undoubtedly, in a considerable number of cases the condition has a true hereditary basis. When the parents of a subject with glioma are blood relations or when bilateral or unilateral gliomas have occurred in a family in the ascendancy, it stands to reason that sterilization must be considered. It is not clear to me how the matter stands in regard to the many nonfamilial cases which are reported by Stock and also by Hemmes from the Netherlands. Tumor formation may depend on somatic mutation, too, which is not hereditary *eo ipso*. Thus, a generally applicable and practical fundamental law cannot be laid down. As to Professor Lindner's remarks on myopia, I am convinced that the modifying influence of close work is a slight one but that there are many reasons for giving it only a minor practical importance. It would take up too much time to go into detail in support of this position, so I shall follow Professor Lindner's course in this respect and merely state my belief without confirmatory data. I agree with Bartels in disapproving of the sterilization of affected males, on account of Lossen's law. It would be important for the sisters of such persons not to reproduce their

kind. It would be better not to characterize retinal detachment as a hereditary malady. So many requirements have to be fulfilled before a detachment actually takes place that it is no wonder that even in the familial cases one finds an irregular dominance. In the case in which the condition is hereditary the tendency to degenerative processes in the retina and the changes in the vitreous, which is embryologically so closely connected with the retina, are to be considered as hereditary disposition. I should like to suggest to Dr. Bücklers that suitable Latin names be used for the types of corneal degeneration and that the term "familial" be abandoned entirely.

(To be continued)

Book Reviews

Introduction to Physiological Optics. By James P. C. Southall, Professor of Physics, Columbia University. Price \$5.50. Pp. 427, with index, table of contents and 135 diagrams and illustrations. New York: Oxford University Press, 1937.

This work covers briefly almost every branch of physiologic optics and is to some extent a condensation of much of the material found in larger works, e. g., Helmholtz' "Physiologic Optics," to which frequent reference is made. Unlike the latter, this book is up to date and incorporates the latest findings in the field of physiologic optics.

The book has, on the whole, the usual rigidly scientific presentation of facts and theory for which Southall is famous, though minor errors of fact are found here and there, largely relating to fine points of anatomy, pure physiology and practical ophthalmologic application. The style is often light and occasionally semipopular. This is probably due to the fact that the book is intended for a variety of readers, including "the large class of intelligent laymen," Incidentally, the latter, more than any one else, will be confused by the author's definition of far-sightedness as synonymous with presbyopia, rather than with hyperopia, as is usual.

Some general statements and recommendations will be seriously questioned by ophthalmologists, e. g., that "latent hyperopia disappears entirely when the patient is refracted by skiascopy or ophthalmoscopy in a dark room," the advice "never to prescribe plus lenses in facultative hyperopia or cylinders in astigmatism until symptoms begin to appear" or the statements "that duccion tests with prisms measure the strength of the extrinsic ocular muscles," and that in presbyopia "less muscular exertion is needed to produce whatever accommodation is still possible."

The chapters on the nature and mechanism of binocular vision, stereoscopic vision, and color and color theories are especially complete. They contain the fundamentals of the various theories and practices underlying these subjects, partly from the standpoint of practical application, but largely from the standpoint of research. A short chapter on rod and cone vision is a well balanced summary of the facts and interpretations which have been accumulated in the past several years, notably by Hecht and his co-workers, and which are scattered in various physiologic and psychologic magazines.

The principal shortcoming of the book from the standpoint of the ophthalmologist is the uniform mathematical approach to the subject. There is an abundance of formulas and symbols, usually Greek, bearing on almost every phase of the subject discussed. Doctors as a rule are poor mathematicians and are probably wholly unaware of the physicist's thrill in juggling around symbols, equations and logarithmic curves. For this reason much of the really fine features of the work will be lost on them, though unquestionably relished by other readers, e. g., "physicists, technical experts in physiological optics and others." In a book written for so wide a variety of readers as this one is such lapses are inevitable.

There is, however, enough easily digestible material of general scientific interest as well as of special ophthalmologic interest to make the book well worth having for reference and consultation.

JOSEPH I. PASCAL, M.D.

In the preface the author stated that this book is intended for intelligent laymen. He added:

At the same time I venture to hope also that technical experts . . . can yet read with profit and enlargement of mind a volume in which both the facts and the theories built upon them are set forth in consistent and logical order. This latter group includes not only specialists in physics, in physiology and biophysics and in psychology but also professional ophthalmologists, illuminating engineers and many representatives of the arts and industries as well as artists and painters, . . .

The extent to which the author has carried out his intention is remarkable. One would certainly believe that the book would be valuable to the specialists mentioned, although the "intelligent layman" and indeed some of the specialists might have some little difficulty with the geometric optics in the first two hundred pages and the analytic geometry in the discussion of colorimetry.

The title of the chapters of the book are:

- I. The Organ of Vision
- II. The Optical System of the Eye
- III. Correction Eye-Glasses
- IV. Hyperopia, Myopia and Astigmatism
- V. Movements of the Eyeball in Its Socket
- VI. Nature of Binocular Vision
- VII. Rod Vision and Cone Vision
- VIII. Colour Vision and Colorimetry
- IX. Concerning Theories of Colour Vision
- X. Temporal and Spatial Reactions of the Organ of Vision

An analysis of the contents of the book indicates that over half of the material is treated from a physical or mathematical point of view. And it is in this treatment which Professor Southall excels. Some knowledge of mathematics is advisable for reading the portions of the book which deal with the optical system of the eye, glasses, ametropia, ocular movements, stereoscopes and colorimetry.

About one third of the book is devoted to the physiologic aspects of physiologic optics, including color vision, accommodation and convergence, rod and cone vision and temporal and spatial reactions of the eye. In general, the physiologic treatment is more elementary than the physical.

The remaining sixth of the book deals with anatomy and physiology of the eye and the psychology of vision.

Since, as the author stated in his preface (p. v), "the material for this volume has been compiled from a course of lectures in physiological

optics which I have given in Columbia University for undergraduate students over a long period of years," it is clear that only the more elementary theories can be presented on many subjects. This is, of course, excellent pedagogic technic, but it is possible that the book would be somewhat improved by giving references to the more advanced views in the literature which the ambitious reader might examine. Thus, after the excellent discussion of the movements of the eyes and of false torsion, Professor Southall gives the impression of denying the existence of real torsion by stating (p. 176): "Obviously, therefore, having only two degrees of freedom as thus indicated, the globe of the eye or the eyeball cannot turn around the line of fixation; although curiously enough most authorities persist in maintaining the contrary." Here a few references might be given to real torsion, such as the following:

Hofmann, F. B., and Bielschowsky, A.: Ueber die der Willkur entzogenen Fusionsbewegungen der Augen, *Arch. f. d. ges. Physiol.* **80**:1, 1900.

Ames, A.: Cyclophoria, *Am. J. Physiol. Optics* **7**:3, 1926.

Herzau, W.: Ueber das Verhältniss von erzwungener Vertikaldivergenz und Rollung bei Fusion, *Arch. f. Ophth.* **122**:59, 1929.

Verhoeff, F. H.: Cycloduction, *Tr. Am. Ophth. Soc.* **32**:208, 1934.

Again, in dealing with the mechanism of accommodation the theory of Helmholtz is the only one presented. Perhaps reference should be made to the promising theory of dual innervation of the ciliary muscle, considered by the following authors:

Henderson, T.: The Anatomy and Physiology of Accommodation in Mammalia, *Tr. Ophth. Soc. U. Kingdom* **46**:300, 1926.

Hudelo, A.: Mécanisme de l'accommodation et myopie diabétique, *Arch. d'opht.* **47**:70, 1930.

Byrne, J. G.: Studies on the Physiology of the Eye, London, H. K. Lewis & Co., Ltd., 1933.

Nicolai, C.: Der Mechanismus der Akkommodation, *Klin. Monatsbl. f. Augenh.* **94**:617, 1935.

Cogan, D.: Accommodation and the Autonomic Nervous System, *Arch. Ophth.* **18**:739 (Nov.) 1937.

Similarly, in the discussion of binocular vision, it is stated (p. 211) that "when the retinal images of one and the same object do not correspond, a double image will be seen." This simplified exposition is, of course, contrary to the views of Bourdon and Verhoeff, among others, which are cited in the following references:

Bourdon, B.: La perception visuelle de l'espace, Paris, 1902, p. 212.

Verhoeff, F. H.: A New Theory of Binocular Vision, *Arch. Ophth.* **13**:151 (Feb.) 1935.

Again, in treating of the Pulfrich phenomenon, Southall advances the usual interpretation based on intensity difference between the two eyes. Perhaps here reference should be given to the possibly more important factor of the relative state of adaptation of the two eyes, as in the following reference:

Granit, R.: Report of a Joint Discussion on Vision, Cambridge, 1932, p. 235.

Almost all of the treatment of rod and cone vision and critical flicker frequency is discussed from the point of view of Hecht. This makes for a unified presentation, but it might be advisable to give the reader references to the more advanced theories. For example, in discussing Hecht's theory of flicker it is said that "the flicker fusion frequency seems to be directly proportional to the concentration x of the photosensitive substance." Hecht, however, is dealing with a special case in which the wave form is rectangular, the dark phase of zero intensity and the dark and light phases of equal length of time. Under these restricted conditions x may be proportional to the maximums of $\frac{dx}{dt}$. Since $\frac{dx}{dt}$ rather than x may well be the controlling factor, the enquiring reader might appreciate references to more thorough treatments of the problem, such as the following:

Ives, H.: A Theory of Intermittent Vision, *J. Optic. Soc. America* 6:343, 1922.

Cobb, P.: Some Comments on the Ives Theory of Flicker, *J. Optic. Soc. America* 24:91, 1934.

Again (p. 404), it is said that "stereoscopic lustre is due entirely to difference of illumination as seen by the two eyes in conjunction." This suggests that "difference of illumination as seen by the two eyes in conjunction" is both a necessary and a sufficient condition for the production of luster. This factor does appear to be necessary, but it is not sufficient, as may be demonstrated by the failure to get stereoscopic luster when a black field is presented to one eye while a white field with no contours is presented to the other eye. Some readers may wish to look into the difficult problem of the effect of contours on luster as discussed in the following article:

Kaiser, H.: Compendium der physiologischen Optik, Wiesbaden, C. W. Kreidel, 1872, pp. 311 and 312.

As Professor Southall said (p. vi): "However, defects of omission can at least be supplied in a future edition provided the book should be good enough to warrant a revision." If, then, Professor Southall could, without sacrificing his powerful didactic style, make some reference to alternative views, the unaided reader would benefit.

Covering the broad field that it does, the volume would appear to be excellent for use as a text in conjunction with lectures or a seminar on physiologic optics, as it presents in clear style exactly what the title implies, an "Introduction to Physiological Optics."

The unassisted reader might draw some false conclusions, but this difficulty may be readily overcome by some modifications.

ELEK JOHN LUDVIGH, PH.D.

Pharmacopoeia of the Government Ophthalmic Hospital, Madras. By Lieutenant-Colonel R. E. Wright and Rao Bahadur K. Koman Nayar. Price 14 annas. Pp. 37, interwoven. Madras, India: Government Press, 1937.

This publication is a formulary of remedies used in diseases of the eye, both locally and generally, consisting of drops, injections, lotions, oils, ointments, pigments, powders and tablets. The collection is very useful and handy.

ARNOLD KNAPP.

Die Kuppelungen von Pupillenstörungen mit Aufhebung der Sehnenreflexe. By F. Kehrer. Price, 4.60 marks. Pp. 56, with 2 illustrations. Leipzig: George Thieme, 1937.

In 1932 Adie collected the bibliography on a condition described as a pupillary disturbance, "pupillotonia," associated with the abolition or reduction of tendon reflexes, particularly of the knee and ankle. This syndrome is also known in the literature as pupillotonia, pseudotabes and constitutional areflexia and now is the subject of this monograph by Prof. F. Kehrer, director of the clinic for nervous diseases in Münster, Germany. The debatable question is, How can these symptoms in widely separated parts of the body be brought under a common pathologicogenetic or causal relation? The subject is treated under the following headings: pupillotonia according to Behr and Adie; pseudotabes; accommodation in pupillotonia; Adie's syndrome; forms of pseudotabes; so-called constitutional areflexia, and other symptoms of pupillotonic pseudotabes. The author comes to the conclusion that the so-called Adie syndrome is only one of a group of symptom complexes suggesting a lesion of a closely confined area in the parasympathetic and sympathetic nervous systems and is produced by a variety of causes. It is one of several syndromes referable to the nervous system which can readily extend to include an adjacent area; it is a group of symptoms but not a disease.

Abnormal wideness of the pupils or occasional accompanying disturbance of accommodation usually brings the patient to the physician. A thorough examination of the eyes and nervous system should be made. The spinal fluid should be carefully examined, and all possible causes for pseudotabes must be investigated.

ARNOLD KNAPP.

Routine Methods of Treatment as Employed from Time to Time in the Government Ophthalmic Hospital, Madras. By Lieutenant-Colonel R. E. Wright and Rao Badhadur K. Koman Nayar. Price, 1 rupee. Pp. 33, interwoven. Madras, India: Government Press, 1937.

This book is a compilation of the methods of treatment which are used in the Government Ophthalmic Hospital, at Madras, India, and serves as a convenient memorandum for postgraduate students who are attending the practice of the hospital. The treatment for protein shock, tests and treatment for tuberculosis, antisyphilitic treatment, narcosis, nonoperative treatment of glaucoma (excellent) and trachoma are only a few of the items which are described.

A great convenience for the student and invaluable for the practitioner, as the material and information presented is often difficult to find, this little book brings the methods which have been approved of by the directing surgeon of the hospital from his vast clinical experience.

ARNOLD KNAPP.

Directory of Ophthalmologic Societies *

INTERNATIONAL

INTERNATIONAL ASSOCIATION FOR PREVENTION OF BLINDNESS

Honorary President: Prof. F. de Lapersonne, 217 Fauborg St. Honoré, Paris.
President: Dr. P. Bailliart, 66 Boulevard Saint-Michel, Paris, 6°.
Secretary-General: Prof. M. Van Duyse, Université de Gand, Gand, Prov. Ostflandern, Belgium.
All correspondence should be addressed to the President, Dr. P. Bailliart.

INTERNATIONAL OPHTHALMOLOGIC CONGRESS

Secretary: Dr. E. Marx, Costzeedijk 316, Rotterdam, Netherlands.

INTERNATIONAL ORGANIZATION AGAINST TRACHOMA

President: Dr. A. F. MacCallan, 33 Welbeck St., London, W., England.

FOREIGN

BRITISH MEDICAL ASSOCIATION, SECTION ON OPHTHALMOLOGY

President: Dr. Stewart Duke-Elder, 59 Harley St., London, W. I.
Secretary: Dr. Thomasina Belt, 13 Mitchell Ave., Jesmond, Newcastle-on-Tyne.
Place: Plymouth. Time: July 20-22, 1938.

CHINESE OPHTHALMOLOGICAL SOCIETY OF PEIPING

President: Dr. H. T. Pi, Peiping Union Medical College, Peiping.
Secretary: Dr. C. K. Lin, 180 Hsi-Lo-yen, Chienmeng, Peiping.
Place: Peiping Union Medical College, Peiping. Time: Last Friday of each month.

GERMAN OPHTHALMOLOGICAL SOCIETY

President: Prof. Lohlein, Jena.
Secretary: Prof. A. Wagenmann, Heidelberg.
Place: Heidelberg. Time: July 4-6, 1938.

MIDLAND OPHTHALMOLOGICAL SOCIETY

President: Dr. T. E. Ashdown Carr, 34 Charnwood St., Derby, England.
Secretary: T. Harrison Butler, 81 Edmund St., Birmingham, England.
Place: Birmingham and Midland Eye Hospital.

OPHTHALMOLOGICAL SOCIETY OF EGYPT

President: Prof. Dr. Sayed Abdel Hamid Soliman Pasha, Faculty of Medicine, Cairo.
Secretary: Dr. Abdel Fattah El Tobgy, 3 Midan Soliman Pasha, Cairo.
Place: Memorial Ophthalmic Laboratory, Giza. Time: March 25, 1938.

OPHTHALMOLOGICAL SOCIETY OF THE UNITED KINGDOM

President: Mr. Gordon M. Holmes, 9 Wimpole St., London, W. 1.
Secretary: Mr. J. D. M. Cardell, 27 Weymouth St., London, W. 1.

OPHTHALMOLOGY SOCIETY OF BOMBAY

President: Dr. D. D. Sathaye, 127 Girgaum Road, Bombay 4.
Secretary: Dr. H. D. Dastur, Dadar, Bombay 14.
Place: H. B. A. Free Ophthalmic Hospital, Parel, Bombay 12. Time: First Friday of every month.

* Secretaries of societies are requested to furnish the information necessary to make this list complete and to keep it up to date.

OXFORD OPHTHALMOLOGICAL CONGRESS

Master: Dr. C. G. Russ Wood, Hill House, Abberbury Rd., Iffley, Oxford, England.

Hon. Secretary-Treasurer: Dr. F. A. Anderson, 12 St. John's Hill, Shrewsbury, England.

Time: July 7-9, 1938.

PALESTINE OPHTHALMOLOGICAL SOCIETY

President: Dr. Arie Feigenbaum, Abyssinian Str. 15, Jerusalem.

Secretary: Dr. E. Sinai, Tel-Aviv.

POLISH OPHTHALMOLOGICAL SOCIETY

President: Dr. W. Kapuściński, 2 Waly Batorego, Poznań.

Secretary: Dr. J. Sobański, Lindley'a 4, Warsaw.

Place: Lindley'a 4, Warsaw.

ROYAL SOCIETY OF MEDICINE, SECTION OF OPHTHALMOLOGY

President: Dr. Ransom Pickard, 31 E. Southernhay, Exeter, England.

Secretary: Dr. A. Rugg-Gunn, 35 Harley St., London, W. 1.

SOCIÉTÉ FRANÇAISE D'OPHTHALMOLOGIE

Secretary: Dr. René Onfray, 6 avenue de la Motte Picquet, Paris, 7è.

SOCIETY OF SWEDISH OPHTHALMOLOGISTS

President: Prof. K. G. Ploman, Stockholm, Sweden.

Secretary: Dr. K. O. Granström, Södermalmstorg 4 III tr., Stockholm, Sö., Sweden.

TEL-AVIV OPHTHALMOLOGICAL SOCIETY

President: Dr. D. Arie-Friedman, 96 Allenby Str., Tel-Aviv.

Secretary: Dr. Sadger Max, 9 Bialik Str., Tel-Aviv.

TSINAN OPHTHALMOLOGICAL SOCIETY

Chairman: Dr. Eugene Chan, Cheeloo University School of Medicine, Tsinan, Shantung.

Place: Cheeloo University School of Medicine. Time: Last Thursday of alternate months.

NATIONAL

AMERICAN MEDICAL ASSOCIATION, SCIENTIFIC ASSEMBLY, SECTION ON OPHTHALMOLOGY

Chairman: Dr. Parker Heath, 1553 Woodward Ave., Detroit.

Secretary: Dr. Derrick T. Vail Jr., 441 Vine St., Cincinnati.

Place: San Francisco. Time: June 13-17, 1938.

AMERICAN ACADEMY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY, SECTION ON OPHTHALMOLOGY

President: Dr. Harry S. Gradle, 58 E. Washington St., Chicago.

Executive Secretary-Treasurer: Dr. William P. Wherry, 1500 Medical Arts Bldg., Omaha.

Place: Washington, D. C. Time: Oct. 9-14, 1938.

AMERICAN OPHTHALMOLOGICAL SOCIETY

President: Dr. Frederick H. Verhoeff, 243 Charles St., Boston.

Secretary-Treasurer: Dr. Eugene M. Blake, 303 Whitney Ave., New Haven, Conn.

Place: San Francisco. Time: June 9-11, 1938.

CANADIAN OPHTHALMOLOGICAL SOCIETY

President: Dr. W. Gordon M. Byers, 1458 Mountain St., Montreal.

Secretary-Treasurer: Dr. Alexander E. MacDonald, 421 Medical Arts Bldg., Toronto.

NATIONAL SOCIETY FOR THE PREVENTION OF BLINDNESS

President: Mr. William Fellowes Morgan, 50 W. 50th St., New York.
Secretary: Miss Regina E. Schneider, 50 W. 50th St., New York.

SECTIONAL

CENTRAL WISCONSIN SOCIETY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

President: Dr. L. C. Gardner, 11 N. Main St., Fond du Lac.
Secretary: Dr. G. L. McCormick, 626 S. Central Ave., Marshfield.
Place: Marshfield. Time: May 1938.

NEW ENGLAND OPHTHALMOLOGICAL SOCIETY

President: Dr. Edwin B. Goodall, 101 Bay State Rd., Boston.
Secretary-Treasurer: Dr. William P. Beetham, 5 Bay State Rd., Boston.
Place: Massachusetts Eye and Ear Infirmary, 243 Charles St., Boston. Time:
8 p. m., third Tuesday of each month from November to April, inclusive.

PACIFIC COAST OTO-OPHTHALMOLOGICAL SOCIETY

President: Dr. William D. Donohue, 1930 Wilshire Blvd., Los Angeles.
Secretary-Treasurer: Dr. C. Allen Dickey, 450 Sutter St., San Francisco.
Place: Victoria, B. C. Time: June 21-24, 1938.

PUGET SOUND ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. A. W. Howe, 740 St. Helens Ave., Tacoma, Wash.
Secretary-Treasurer: Dr. Purman Dorman, 1115 Terry Ave., Seattle.
Place: Seattle or Tacoma, Wash. Time: Third Tuesday of each month, except
June, July and August.

ROCK RIVER VALLEY EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. Frank W. Broderick, 501 Central Trust Bldg., Sterling, Ill.
Secretary-Treasurer: Dr. Thorsten E. Blomberg, 501-7th St., Rockford, Ill.
Place: Rockford, Ill., or Janesville or Beloit, Wis. Time: Third Tuesday of
each month.

SAGINAW VALLEY ACADEMY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

President: Dr. W. K. Slaek, 308 Eddy Bldg., Saginaw, Mich.
Secretary-Treasurer: Dr. Andre Cortopassi, 703 Second National Bank Bldg.,
Saginaw, Mich.
Place: Saginaw or Bay City, Mich. Time: Second Tuesday of each month,
except July and August.

SIOUX VALLEY EYE AND EAR ACADEMY

President: Dr. J. H. Judd, 107 S. 17th St., Omaha, Neb.
Secretary-Treasurer: Dr. J. C. Decker, 515 Frances Bldg., Sioux City, Iowa.

SOUTHERN MEDICAL ASSOCIATION, SECTION ON EYE, EAR, NOSE AND THROAT

Chairman: Dr. Grady E. Clay, Medical Arts Bldg., Atlanta, Ga.
Secretary: Dr. John R. Hume, 921 Canal St., New Orleans.

SOUTHWESTERN MICHIGAN TRIOLOGICAL SOCIETY

President: Dr. John Hunter McRae, 26 Sheldon Ave., S. E., Grand Rapids, Mich.
Secretary-Treasurer: Dr. Dewey R. Heetderks, 405 Medical Arts Bldg., Grand
Rapids, Mich.
Time: Third Thursday of alternate months.

WESTERN PENNSYLVANIA EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. C. M. Harris, Johnstown, Pa.
Secretary-Treasurer: Dr. C. Wearne Beals, Weber Bldg., DuBois.
Place: Johnstown, Pa. Time: May 19, 1938.

STATE

COLORADO OPHTHALMOLOGICAL SOCIETY

President: A presiding officer is selected for each meeting alternately until all members have served.

Secretary: Dr. John C. Long, 324 Metropolitan Bldg., Denver.

Place: Capitol Life Bldg., Denver. Time: 7:30 p. m., third Saturday of the month, October to April, inclusive.

CONNECTICUT STATE MEDICAL SOCIETY, SECTION ON EYE, EAR,
NOSE AND THROAT

President: Dr. Charles T. Flynn, 41 Trumbull St., New Haven.

Secretary-Treasurer: Dr. Shirley H. Baron, 309 State St., New London.

Place: New London. Time: February 1938.

EYE, EAR, NOSE AND THROAT CLUB OF GEORGIA

President: Dr. John King, Thomasville.

Secretary-Treasurer: Dr. Mason Baird, 384 Peachtree St., Atlanta.

Place: Augusta. Time: May 1938.

INDIANA ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. E. E. Holland, 51 S. 8th St., Richmond.

Secretary: Dr. Marlow W. Manion, 23 E. Ohio St., Indianapolis.

Place: Indianapolis. Time: April 6, 1938.

IOWA ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. H. H. Lamb, American Bank Bldg., Davenport.

Secretary-Treasurer: Dr. B. M. Merkel, 604 Locust St., Des Moines.

Place: Davenport.

LOUISIANA-MISSISSIPPI OPHTHALMOLOGICAL AND OTOLARYNGOLOGICAL SOCIETY

President: Dr. C. A. McWilliams, G. and S. I. R. R. Bldg., Gulfport, Miss.

Secretary-Treasurer: Dr. Edley H. Jones, 1301 Washington St., Vicksburg, Miss.

Place: New Orleans. Time: Spring, 1938.

MICHIGAN STATE MEDICAL SOCIETY, SECTION OF OPHTHALMOLOGY
AND OTOLARYNGOLOGY

Chairman: Dr. F. N. Smith, Grand Rapids Clinic, Grand Rapids.

Secretary: Dr. Dewey R. Heetderks, 26 Sheldon Ave., S. E., Grand Rapids.

MINNESOTA ACADEMY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

President: Dr. Walter E. Camp, 1918 Medical Arts Bldg., Minneapolis.

Secretary-Treasurer: Dr. George E. McGeary, 920 Medical Arts Bldg., Minneapolis.

Time: Second Friday of each month from October to May.

MONTANA ACADEMY OF OTO-OPHTHALMOLOGY

President: Dr. Edward S. Murphy, Northern Pacific Hospital, Missoula.

Secretary: Dr. A. W. Morse, 507 Phoenix Bldg., Butte.

NEW JERSEY STATE MEDICAL SOCIETY, SECTION ON OPHTHALMOLOGY,
OTOLOGY AND RHINOLARYNGOLOGY

Chairman: Dr. Oram Kline, 414 Cooper St., Camden.

Secretary: Dr. James S. Shipman, 542 Cooper St., Camden.

NEW YORK STATE MEDICAL SOCIETY, EYE, EAR, NOSE AND THROAT SECTION

Chairman: Dr. Marvin F. Jones, 121 E. 60th St., New York.

Secretary: Dr. Algernon B. Reese, 73 E. 71st St., New York.

Time: May 10, 1938.

NORTH CAROLINA EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. J. M. Lilly, 302 Old St., Fayetteville.
 Secretary-Treasurer: Dr. Frank C. Smith, 106 W. 7th St., Charlotte.
 Place: Charlotte. Time: October.

NORTH DAKOTA ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. H. Rosenberger, 221-5th St., Bismarck.
 Secretary-Treasurer: Dr. F. L. Wicks, 514-6th St., Valley City.
 Place: Bismarck. Time: May 1938.

OREGON ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. A. B. Dykman, Medical Dental Bldg., Portland.
 Secretary-Treasurer: Dr. Andrew J. Browning, 418 Mayer Bldg., Portland.
 Place: Good Samaritan Hospital. Time: Third Tuesday of each month.

RHODE ISLAND OPHTHALMOLOGICAL AND OTOLOGICAL SOCIETY

Acting President: Dr. N. Darrell Harvey, 112 Waterman St., Providence.
 Secretary-Treasurer: Dr. Linley C. Happ, 124 Waterman St., Providence.
 Place: Rhode Island Medical Library. Time: 8:30 p. m., second Thursday in October, December, February and April.

SOUTH CAROLINA SOCIETY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

President: Dr. George Truluck, Orangeburg.
 Secretary: Dr. J. W. Jervey Jr., 101 Church St., Greenville.

TENNESSEE ACADEMY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

President: Dr. Kate Savage Zerfoss, 165-8th Ave., N., Nashville.
 Secretary-Treasurer: Dr. W. D. Stinson, 805 Medical Arts Bldg., Memphis.
 Place: Nashville. Time: April 12-13, 1938.

TEXAS OPHTHALMOLOGICAL AND OTO-LARYNGOLOGICAL SOCIETY

President: Dr. T. E. Fuller, 100 W. Board St., Texarkana, Texas.
 Secretary: Dr. O. M. Marchman, 1719 Pacific Ave., Dallas.

UTAH OPHTHALMOLOGICAL SOCIETY

President: Dr. V. P. White, 143½ S. Main St., Salt Lake City.
 Secretary-Treasurer: Dr. E. B. Fairbanks, Boston Bldg., Salt Lake City.
 Time: Third Monday of each month.

VIRGINIA SOCIETY OF OTO-LARYNGOLOGY AND OPHTHALMOLOGY

President: Dr. M. H. Hood, 505 Washington St., Portsmouth.
 Secretary-Treasurer: Dr. Charles T. St. Clair, 418 Bland St., Bluefield, W. Va.

WEST VIRGINIA STATE MEDICAL ASSOCIATION, EYE, EAR, NOSE
AND THROAT SECTION

President: Dr. George Traugh, 309 Cleveland Ave., Fairmont.
 Secretary: Dr. Welch England, 621½ Market St., Parkersburg.

LOCAL

ACADEMY OF MEDICINE OF NORTHERN NEW JERSEY, SECTION ON
EYE, EAR, NOSE AND THROAT

President: Dr. James A. Fisher, 501 Grand Ave., Asbury Park.
 Secretary: Dr. William F. McKim, 488 Sanford Ave., Newark.
 Place: 91 Lincoln Park South, Newark. Time: 8:45 p. m., second Monday of each month, October to May.

AKRON ACADEMY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

President: Dr. L. E. Brown, Second National Bldg., Akron.

Secretary-Treasurer: Dr. C. R. Anderson, 106 S. Main St., Akron.

Time: First Monday in January, March, May and November.

ATLANTA EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. J. Mason Baird, Medical Arts Bldg., Atlanta, Ga.

Secretary: Dr. Alton V. Hallum, 478 Peachtree St., Atlanta, Ga.

Place: Academy of Medicine, 38 Prescott St. Time: Second Friday of each month from October to May.

BALTIMORE MEDICAL SOCIETY, SECTION ON OPHTHALMOLOGY

Chairman: Dr. Henry F. Graff, 513 N. Charles St., Baltimore.

Secretary: Dr. Frank B. Walsh, Wilmer Institute, Johns Hopkins Hospital, Baltimore.

Place: Medical and Chirurgical Faculty, 1211 Cathedral St. Time: 8:30 p. m., fourth Thursday of each month from October to May.

BROOKLYN OPHTHALMOLOGICAL SOCIETY

President: Dr. Walter V. Moore, 1 Nevins St., Brooklyn.

Secretary-Treasurer: Dr. Mortimer A. Lasky, 1 Nevins St., Brooklyn.

Place: Kings County Medical Society Bldg., 1313 Bedford Ave. Time: Third Thursday in February, April, May, October and December.

BUFFALO OPHTHALMOLOGIC CLUB

President: Dr. Ivan J. Koenig, 40 North St., Buffalo.

Secretary-Treasurer: Dr. Meyer H. Rivchun, 367 Linwood Ave., Buffalo.

Time: Second Thursday of each month.

CHATTANOOGA SOCIETY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

President: Each member, in alphabetical order.

Secretary: Dr. A. H. Benz, 706 Medical Arts Bldg., Chattanooga.

Place: Mountain City Club. Time: Second Thursday of each month from September to May.

CHICAGO OPHTHALMOLOGICAL SOCIETY

President: Dr. Thomas D. Allen, 122 S. Michigan Blvd., Chicago.

Secretary-Treasurer: Dr. Earle B. Fowler, 55 E. Washington St., Chicago.

Place: Medinah Michigan Avenue Club, 505 N. Michigan Ave. Time: Third Monday of each month from October to May.

CINCINNATI OPHTHALMIC CLUB

Chairman: Each member, in rotation.

Secretary-Treasurer: Dr. E. R. Thomas, 819 Carew Tower, Cincinnati.

Place: Holmes Memorial Library, Cincinnati General Hospital. Time: 8:15 p. m., third Monday of each month except June, July and August.

CLEVELAND ACADEMY OF MEDICINE, SECTION OF OPHTHALMOLOGY
AND OTOLARYNGOLOGY

Chairman: Dr. Webb Chamberlin, 7405 Detroit Ave., Cleveland.

Secretary: Dr. Walter H. Rieger, Hanna Bldg., Cleveland.

Place: Winton Hotel. Time: Fourth Friday of each month.

CLEVELAND OPHTHALMOLOGICAL CLUB

Chairman: Dr. Paul Moore, Republic Bldg., Cleveland.

Secretary: Dr. G. Leslie Miller, 14805 Detroit Ave., Cleveland.

Time: Second Tuesday in October, December, February and April.

COLLEGE OF PHYSICIANS, PHILADELPHIA, SECTION ON OPHTHALMOLOGY

Chairman: Dr. Charles R. Heed, 1205 Spruce St., Philadelphia.
 Clerk: Dr. Alexander G. Fewell, 1924 Pine St., Philadelphia.
 Time: Third Thursday of every month from October to April, inclusive.

COLUMBUS OPHTHALMOLOGICAL AND OTO-LARYNGOLOGICAL SOCIETY

Chairman: Dr. C. E. Silbernagle, 247 E. State St., Columbus, Ohio.
 Secretary-Treasurer: Dr. D. M. Johnson, 327 E. State St., Columbus, Ohio.
 Place: Deshler Wallick Hotel. Time: 6 p. m., first Monday of each month.

CORPUS CHRISTI EYE, EAR, NOSE AND THROAT SOCIETY

Chairman: Dr. Edgar G. Mathis, 416 Chaparral St., Corpus Christi, Texas.
 Secretary: Dr. E. King Gill, 416 Chaparral St., Corpus Christi, Texas.
 Time: Second Thursday of each month from October to May.

DALLAS ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. Lester H. Quinn, 4105 Live Oak, Dallas, Texas.
 Secretary: Dr. J. Dudley Singleton, 1719 Pacific Ave., Dallas, Texas.
 Place: Dallas Athletic Club. Time: 6:30 p. m., first Tuesday of each month from October to June. The November, January and March meetings are devoted to clinical work.

DES MOINES ACADEMY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

President: Dr. E. G. Linn, 604 Locust St., Des Moines, Iowa.
 Secretary-Treasurer: Dr. Grace Doane, 614 Bankers Trust Bldg., Des Moines, Iowa.
 Time: 7:45 p. m., third Monday of every month from September to May.

DETROIT OPHTHALMOLOGICAL CLUB

Chairman: Members rotate alphabetically.
 Secretary: Dr. William Fowler, 1424 Maccabee Bldg., Detroit.
 Time: 6:30 p. m., first Wednesday of each month.

EASTERN NEW YORK EYE, EAR, NOSE AND THROAT ASSOCIATION

President: Dr. J. D. Carroll, 102—3d St., Troy, N. Y.
 Secretary-Treasurer: Dr. Joseph L. Holohan, 330 State St., Albany.
 Time: Third Wednesday in October, November, March, April, May and June.

FORT WORTH EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. Van D. Rathgeber, 1012 Medical Arts Bldg., Fort Worth, Texas.
 Secretary-Treasurer: Dr. Charles R. Lees, 306 W. Broadway, Fort Worth, Texas.
 Place: Medical Hall, Medical Arts Bldg. Time: 7:30 p. m., first Friday of each month except July and August.

GRAND RAPIDS EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. Dewey R. Heetderks, 405 Medical Arts Bldg., Grand Rapids, Mich.
 Secretary-Treasurer: Dr. Robert G. Laird, 116 E. Fulton St., Grand Rapids, Mich.
 Place: Various local hospitals. Time: Third Thursday of alternating months, September to May.

HOUSTON ACADEMY OF MEDICINE, EYE, EAR, NOSE AND THROAT SECTION

President: Dr. L. Allen, 1215 Walker Ave., Houston, Texas.
 Secretary: Dr. George C. Farrish, 1625 Main St., Houston, Texas.
 Place: Medical Arts Bldg., Harris County Medical Society Rooms. Time: 8 p. m., second Thursday of each month from September to June.

INDIANAPOLIS OPHTHALMOLOGICAL AND OTOLARYNGOLOGICAL SOCIETY

President: Dr. C. P. Clark, 24 E. Ohio St., Indianapolis.

Secretary: Dr. Kenneth L. Craft, 23 E. Ohio St., Indianapolis.

Place: University Club. Time: 6:30 p. m., second Thursday of each month from October to May.

KANSAS CITY SOCIETY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. O. S. Gilliland, 1103 Grand Ave., Kansas City, Mo.

Secretary: Dr. John S. Knight, 1103 Grand Ave., Kansas City, Mo.

Time: Third Thursday of each month from September to May. The November, January and March meetings are devoted to clinical work.

LONG BEACH EYE, EAR, NOSE AND THROAT SOCIETY

Chairman: Dr. F. C. Hertzog, 117 E. 8th St., Long Beach, Calif.

Secretary-Treasurer: Dr. Ben K. Parks, 619 Professional Bldg., Long Beach, Calif.

Place: Professional Bldg. Time: Last Wednesday of each month from October to May.

LOS ANGELES SOCIETY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. Isaac H. Jones, 1930 Wilshire Blvd., Los Angeles.

Secretary-Treasurer: Dr. John P. Lordan, 2007 Wilshire Blvd., Los Angeles.

Place: Los Angeles County Medical Association Bldg., 1925 Wilshire Blvd. Time: 6:30 p. m., fourth Monday of each month from September to May, inclusive.

LOUISVILLE EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. J. S. Bumgardner, Heyburn Bldg., Louisville, Ky.

Secretary-Treasurer: Dr. Max Bornstein, Heyburn Bldg., Louisville, Ky.

Place: Brown Hotel. Time: 6:30 p. m., second Thursday of each month from September to May, inclusive.

MEDICAL SOCIETY OF THE DISTRICT OF COLUMBIA, SECTION OF
OPHTHALMOLOGY AND OTOLARYNGOLOGY

Chairman: Dr. Earle Breeding, 1801 I St., N. W., Washington.

Secretary: Dr. Elmer Shepherd, 1606—20th St., N. W., Washington.

Place: 1718 M St., N. W. Time: 8 p. m., third Friday of each month from October to April, inclusive.

MEMPHIS SOCIETY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

Chairman: Each member, in alphabetical order.

Secretary: Dr. Sam H. Sonders, Medical Arts Bldg., Memphis, Tenn.

Place: Eye Clinic of Memphis Eye, Ear, Nose and Throat Hospital. Time: 8 p. m., second Tuesday of each month.

MILWAUKEE OTO-OPHTHALMIC SOCIETY

President: Dr. Thomas A. Judge, 735 N. Water St., Milwaukee.

Secretary-Treasurer: Dr. John B. Hitz, 208 E. Wisconsin Ave., Milwaukee.

Place: University Club. Time: 6:30 p. m., second Tuesday of each month.

MINNEAPOLIS OPHTHALMOLOGICAL SOCIETY

Chairman: Each member, in alphabetical order.

Secretary: Dr. M. C. Pfunder, 645 Medical Arts Bldg., Minneapolis.

Place: Hennepin County Medical Society rooms. Time: 6:30 p. m., fourth Monday of each month, October to May, inclusive.

MONTGOMERY COUNTY MEDICAL SOCIETY

Chairman: Dr. A. G. Farmer, 1040 Fidelity Bldg., Dayton, O.

Secretary-Treasurer: Dr. Rome M. Webster, 663 Reibold Bldg., Dayton, O.

Place: Van Cleve Hotel. Time: 6:30 p. m., bimonthly, first Tuesday from October to June, inclusive.

MONTREAL OPHTHALMOLOGICAL SOCIETY

President: Dr. Stuart Ramsay, 1496 Mountain St., Montreal, Canada.
 Secretary: Dr. J. Rosenbaum, 1396 St. Catherine St., W., Montreal, Canada.
 Time: Second Thursday of October, December, February and April.

NASHVILLE ACADEMY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

Chairman: Dr. Guy Maness, 119-7th Ave., Nashville, Tenn.
 Secretary-Treasurer: Dr. Andrew Hollabaugh, Doctors Bldg., Nashville, Tenn.
 Place: St. Thomas Hospital. Time: 8 p. m., third Monday of each month from October to May.

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 Place: Eye, Ear, Nose and Throat Hospital. Time: Third Thursday of each month from October to June.

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 Secretary: Dr. Rudolf Aebli, 30 E. 40th St., New York.
 Time: 8:30 p. m., third Monday of every month from October to May, inclusive.

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President: Dr. Mark J. Schoenberg, 1160 Park Ave., New York.
 Secretary: Dr. Jesse Stark, 45 Park Ave., New York.
 Place: Squibb Hall, 745-5th Ave. Time: 7 p. m., first Monday of each month from October to May, inclusive.

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 Secretary-Treasurer: Dr. Delbert K. Judd, 1020 Medical Arts Bldg., Omaha.
 Place: Omaha Club, 20th and Douglas Sts., Omaha. Time: 6 p. m., dinner;
 7 p. m., program; third Wednesday of each month from October to May.

OPHTHALMOLOGICAL SOCIETY OF THE UNIVERSITY OF PITTSBURGH

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 Secretary: Dr. George H. Shuman, 351-5th Ave., Pittsburgh.
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 Secretary: Dr. Richard W. Vaughan, Medical Arts Bldg., Richmond, Va.
 Place: Westmoreland Club. Time: 6 p. m., second Monday of each month from October to May.

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 Place: Rochester Medical Association, 113 Prince St. Time: 8 p. m., third
 Monday of each month from October to May.

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 Secretary: Dr. Leslie Charles Drews, 508 N. Grand Blvd., St. Louis.
 Place: Oscar Johnson Institute. Time: Clinical meeting 5:30 p. m., dinner and
 scientific meeting 6:30 p. m., fourth Friday of each month from October to
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 Place: Shreveport Charity Hospital. Time: 7:30 p. m., first Monday of every
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President: Dr. Raymond A. Lower, 407 Riverside Ave., Spokane, Wash.
 Secretary: Dr. Louis A. Parsell, Paulsen Medical and Dental Bldg., Spokane,
 Wash.
 Place: Paulsen Medical and Dental Library. Time: 8 p. m., fourth Tuesday of
 each month except June, July and August.

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 Secretary-Treasurer: Dr. I. Herbert Katz, 212 Medical Arts Bldg., Syracuse,
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 Place: University Club. Time: First Tuesday of each month except June, July
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 Time: First Monday of each month, November to April.

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 Place: Episcopal Eye, Ear and Throat Hospital. Time: 8 p. m., first Monday
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LOCAL BLOODLETTING IN OPHTHALMIC PRACTICE

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NEW YORK

Local bloodletting is a time-honored remedy which has fallen into disuse in recent years, being replaced by other methods, more in keeping with newer concepts. However, it is a potent remedy, effecting instantaneous relief from pain and influencing the course of the inflammation. It was practiced by the application of leeches, which mode was abandoned as not compatible with the ideas of antisepsis (although I have never heard of or seen any ill effects from the method), so that nowadays one cannot find leeches in a modern drugstore. This led to the development of the "artificial leech," a trephine-like knife which, quickly rotating cuts through the cutis and produces one or several sharp-edged, circular, profusely bleeding wounds. The place for the application of leeches and of the artificial leech is usually the temple; natural leeches were sometimes applied under the eye.

That local bloodletting is no longer in the armamentarium of the modern ophthalmologist was apparent to me a few years ago, when I heard a paper read in which mention was made of the beneficial effects of leeches used under the eye in cases of scleritis or episcleritis. At that time I mentioned that I often used local bloodletting at the site of the condition.

Bloodletting is beneficial for a number of ocular conditions in which congestion is a prominent symptom and for some in which it is not. It is particularly efficient in relieving the following conditions, and I shall describe the mode of my procedure. While I am not the only one practicing bloodletting at the site of involvement, I do not think that it is in general use or that many of my colleagues are cognizant of the method.

INDICATIONS FOR BLOODLETTING

Persistent Episcleritis.—This condition consists of a torpid localized congestion and swelling of the episclera and sclera, lasting from six weeks to several months. It is benign and sometimes painful and has been variously ascribed to rheumatism, gout and tuberculosis. I advise letting it develop fully, and I especially advise that bloodletting be not

mentioned to the patient during his first visit. After the patient realizes the chronic nature of his condition, he will be more willing to submit to the procedure.

Sharp-pointed iris scissors are used. The patient is directed to turn his eye in if the episcleritis is temporal and out if it is nasal. The eyeball may be held with bare index finger and thumb between the separated lids. Cocaine should not be used on account of its vasoconstricting effect, which would prevent profuse bleeding and therefore defeat the object of the operation. The desirability of profuse bleeding is also the reason why the scissors should be very sharp. The scissors should be opened from 6 to 7 mm. wide and directed at a tangent toward the sclera, and with a quick cut a V-shaped wound is produced through the conjunctiva and episclera. No bandage is necessary. This will dispose of episcleritis in most cases. Rarely I find it necessary to repeat the performance after an interval of a week. There is no possibility of cutting through the sclera. Any one who prefers a knife may take a razor-sharp scalpel and with quick cuts (holding the knife lightly between the fingers) make a cross cut through the nodule. I do not believe that there is a possibility of cutting into or through the sclera.

Iritis and Iridocyclitis.—These conditions, no matter what the cause, especially when dark congestion is present, will be favorably influenced by local bloodletting. With the sharp iris scissors, several cuts are made on the lower half of the eyeball from 7 to 8 mm. from the limbus. Also, the effect of atropine on the pupil is greatly enhanced by bloodletting.

Chronic Trachoma with Exacerbations.—For the treatment of this condition the upper lid is everted and a very sharp scalpel is lightly drawn over the conjunctiva and tarsus; two or three cuts are made straight across, especially in the more vascular furrow 2 mm. from the edge of the lid. The patient is directed to look down, and the lower lid is slipped under the upper to protect the eyeball. The knife is turned with the edge upward, and several cuts are made blindly as near as possible to the fornix and farther down. The knife must be lightly held and be very sharp. If it were not extremely sharp, it would defeat the object of the procedure (which is profuse bleeding), and scar formation would result. If the operation is correctly performed, no scars result. The lower lid is treated the same way.

Subacute Conjunctivitis.—The same procedure is used for this condition that is used in cases of trachoma. Patients are frequently greatly relieved and demand performance of the scarification. It has always been a mystery to me that a congested conjunctiva not only becomes

pale immediately after a little bloodletting but may remain so for at least several hours. The good effect can be noticed even after two days.

Relapsing Abrasion of the Cornea.—This troublesome condition of the cornea occurs especially when a cinder has been removed by scraping but also after other types of trauma. Relapsing abrasion is known to every practicing ophthalmologist. The underlying pathologic process is obscure, but it seems related to herpes. How obscure it is, is evidenced by the fact that in "Kurzes Handbuch der Ophthalmologie"¹ several pages are devoted to it, after the perusal of which the reader is left with the distinct conviction that one does not know anything certain about it. My teacher Arlt, whose therapy after sixty years is still unexcelled in most instances, recommended that the eye be bandaged for about five days, after which the abrasion usually remains healed until the next recurrence. By some obscure reasoning, considering that the seat of the trouble is the conjunctival layer of the cornea, I tried scarification of the conjunctiva, with brilliant results in most cases. After scarification, the lids are slightly brushed with a 0.25 per cent silver nitrate solution, and the eye is left unbandaged. The graver forms of this condition, associated with blister formation, loosening of the epithelium of the whole cornea and hypotony, do not yield so strikingly to this treatment but are favorably influenced by it.

1. Schieck, F., and Brückner, A.: Kurzes Handbuch der Ophthalmologie, Berlin, Julius Springer, 1930, vol. 4, pp. 389-391.

CLINICAL ANGIOSCOTOMETRY

A NEW METHOD, WITH THE USE OF DIFFERENT CONTRAST TEST OBJECTS

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KHARKOV, U. S. S. R.

Foerster and Aubert were the first (1857) to suggest the use of perimetry for clinical and experimental purposes. This method has given many valuable contributions to clinical and experimental ophthalmology, but after a lapse of thirty years it was found insufficient for examination of the defects of the central visual field. Bjerrum and his followers, particularly Rönne, elaborated in detail the methods of campimetric examination of the visual field.

Under the influence of the Bjerrum school, ophthalmologists became accustomed to regard various defects of the visual field detected by perimetric and campimetric examinations as defects of nerve fiber bundles.

It is interesting that first Hess and then Igersheimer forewarned against the use of minute or dot objects for campimetric investigations.

In his special article on dot perimetry Hess discussed the question of the theory of using small test objects. By means of calculations he showed that images of small objects on the retina may be lesser than, or of the same size as, the retinal vessels. He came to the conclusion that with an entirely normal visual field and no defects provoked therein by the lesions of the optic nerve fibers, the irregularities may be of an occasional character. These defects disseminated in the visual field are due to the presence of rather thick arteries and veins in the inner retinal layers, which hinder the striking of light on the layer of rods and cones immediately underlying these vessels.

The most recent American and English literature on campimetric examination contains special warnings on this subject. The authors use 1 mm. test objects at a distance of 2 meters (Evans, Traquair), i. e., such as those against which Hess and Igersheimer warned.

Studying the blindspot, many investigators, beginning with Helmholtz, recorded that this has not only an oval form but also some dented

From the Hirshman Memorial Central Ophthalmic Institute (Director, E. B. Rabkin).

shoots which immediately disappear. Helmholtz regarded these shoots as physiologic defects of the visual field and negative images of the retinal vessels from the optic nerve. It was only in 1926 that Evans, using on the stereocampimetric minute, almost dotlike objects, obtained a complete negative image of the retinal vascular system. These ribbon-shaped defects of the visual field, or angioscotomas, said Evans, are the result of the light rays not reaching the optic receptors, on account of the presence in the internal retinal layers not only of large vessels but also of perivascular, lymphatic spaces.

Evans (1926) and Magitot (1935) found that angioscotomas seen on the stereocampimeter are larger than the corresponding vessels. Both authors attribute that to the perivascular lymphatic spaces present. Evans and other authors described a series of angioscotometric investigations on normal eyes and on many eyes with pathologic changes. It appears that the eye with pathologic changes gives an extraordinarily variegated picture of angioscotometric changes of the visual field. Although they had noted and described many series of such changes in glaucoma, periphlebitis and other diseases, Evans and Magitot could not find changes which would be characteristic for singular ocular diseases.

The usual campimetric method of examination, recommended by the Bjerrum school, proved useless for examination in cases of defects of nerve fiber bundles in the visual field with narrow angioscotomas, and not sufficiently precise for the defining of the blindspot and its size. When I made examinations of the blindspot and checked results on the campimeter, I observed that the patient generally shows slowness in his answers in cases of disappearance of the test object and also in cases of its reappearance. Hence I came to the conclusion that the size of the blindspot may vary, depending on whether the test object is seen moving centrifugally or centripetally as regards the centrum of the blindspot. In each case the limits of the blindspot are incorrect. It is impossible to find out the individual errors for each person examined; hence the definition of the size of the blindspot with Bjerrum's method appears not sufficiently precise. This necessitates the elaboration of a new method which may make the examination more precise and permit one to make quantitative measurements of the blindspot and of the angioscotomas.

My method is very simple. When an angioscotoma corresponding to a large retinal vessel is measured campimetrically, its physiologic diameter is generally found to be from 5 to 10 mm. If one makes the examination of an angioscotoma with a small test object moving perpendicularly to the direction of the angioscotoma, the image of the test

object disappears at a certain point in the region of the defect of the visual field. But the image of a sufficiently large test object, the diameter of which exceeds the size of the angioscotoma, when moved in the same direction will pass above this ribbon-shaped defect of the visual field and will not disappear. Consequently if one begins the examination with a small test object and gradually takes other objects each with a diameter 1 mm. larger than the preceding object, one may find an object the image of which will disappear in the patient's visual field for only an instant—and reappear at once. The image of the next object, i. e., that with a diameter 1 mm. larger, will not disappear totally in the visual field. As it passes through the angioscotoma only a portion of it will disappear; i. e., the test object will appear to the patient of a lesser size, but there will be no moment when the patient may think that it has disappeared even for an instant.

The size of the test object the image of which is the last one to disappear even for only an instant in the measured angioscotoma represents, beyond doubt, the exact diameter of the angioscotoma on the campimeter.

I elaborated a test object of a special type and a new method for examination of the blindspot and angioscotomas, which highly differs from those in use and described in the ophthalmologic literature; it is based on the principle of campimetric examination by aid of contrast test objects.

ESSENTIALS OF MY METHOD

After the outlines of the blindspot have been checked on the campimeter in the usual way by Bjerrum's method, I make the measurement of the blindspot's diameter by aid of a special test object in the form of a long band of paper 5 mm. wide, enclosed in a black, narrow, flat case. The back side of this band is graduated in millimeters. This band slides freely in the case. Its protruding end serves as a test object, and one may vary its size from 0 to 300 mm. The test object is generally moved so that its image passes through the horizontal diameter of the blindspot in the centrifugal or the centripetal direction. For the first movement one takes a test object 85 mm. long (on condition that the patient's eyes are fixed on the center of the campimeter at a distance of 1 meter). When one moves the test object slowly there is a moment when the image of this object enters the region of the blindspot. The length of the test object appears to the patient to become smaller and smaller as the image of the object gradually penetrates inside the scotoma. The black case remains invisible on the background of the campimeter. If the diameter of the blindspot is larger than 85 mm. a moment will come when the image of the whole white test object will

disappear in a scotoma for an instant. The next moment the patient will say that the image of the anterior end of the test object makes its appearance out of the region of the scotoma. Finally, when the diameter of the blindspot is less than 85 mm., the anterior end of the test object, the image of which is emerging out of the region of the blindspot, will appear on the other side of the scotoma, i. e., before the posterior end of the test object, the image of which is entering the scotoma, disappears. The patient will observe now that the test object, which he had seen formerly by the sidelong glance, appears in the form of two white dots or as short bands with a black space between.

In the case in which the image of the test object 85 mm. long disappears totally in the blindspot, it is necessary to enlarge its length gradually and choose a length such that the image of the object will disappear in the scotoma for only an instant and with its smallest enlargement will disappear no more.

Finally, in the case in which the diameter of the blindspot is less than 85 mm., it will be necessary to diminish the size of the object until one defines the size of the diameter of the scotoma in the aforementioned manner.

The measuring of the blindspot's diameter with a gray test object is performed in the same manner.

After defining the outline of the blindspot, one draws the outlines of the angioscotomas. For this purpose a 3 mm. test object is moved at some distance along the outline of the blindspot, and all places are checked where the patient sees the test object disappearing. Then the same test object is moved not far from each of the checked dots.

Thus are defined the quantity and the direction of the angioscotomas emerging out of the blindspot.

To draw in detail an angioscotoma tree by the Bjerrum method is difficult and painstaking; it is much easier to check only the direction of the angioscotomas, without drawing their size on the campimeter (fig. 1). This can be done only by the method described for the measurement of the diameter of scotomas. In fact, if one tries to move through the diameter of some angioscotoma the images of gradually larger and larger test objects, it will appear that to measure the diameter of an angioscotoma is as easy as to measure the diameter of the blindspot.

The results of such investigations are checked in the form of fractions. The numerator shows the diameter of a scotoma measured with a white test object, and the denominator shows the diameter obtained with a gray test object.

In the Hirshman Memorial Central Ophthalmic Institute are measured: the horizontal diameter of a blindspot (*BS*), the diameter of an

angioscotoma corresponding to one of the large vascular trunks not far from the optic disk (*AS*) (this measurement is generally made at 45 degrees downward or upward from the horizontal meridian³, and, finally, the diameter of an angioscotoma corresponding to a branch of a small macular vessel (*ASm*). These measurements are made in a simple manner. To draw the contour of a blindspot it suffices to define its limits in from six to eight points on the campimeter, moving a small (3 mm.) test object in the centripetal direction as regards the center of a scotoma. Then the same test object is moved from the center of the campimeter toward the periphery on a radius located 45 degrees upward or downward from the horizontal line. At a distance of from 15 to 16 degrees from the center, the test object which is moved on the

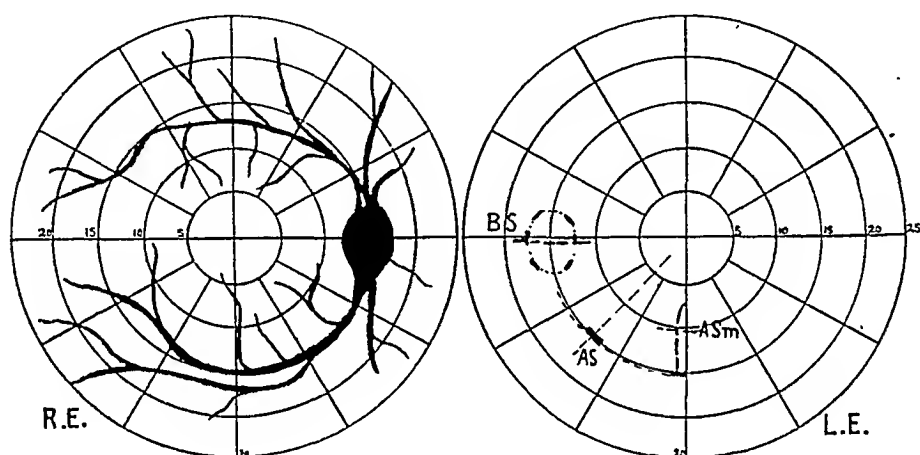


Fig. 1.—The right field shows a normal angioscotometric picture. In the left field the measurement of the blindspot (*BS*) and the angioscotomas (*AS* and *ASm*) by the new method is illustrated.

radius disappears suddenly out of view of the patient. Hence here is located the angioscotoma corresponding to a trunk of a large vessel.

When the test object is moved from the center vertically upward or downward and then at a distance of from 15 to 16 degrees, one may meet the continuation of the angioscotoma which was found formerly.

Now if one moves the small-test object from 1 to 2 mm. parallel to the direction of the angioscotoma, it will be possible to find its branches, which run toward the center and correspond to the branches of the macular vessel. The outlines of the macular angioscotomas (*ASm*) are drawn on the campimeter; their measurement is made at a distance of 10 degrees from the center.

The angioscotometric index for the normal eye shows little difference in the values for the numerator and the denominator. This index

for eyes with pathologic changes often shows great variations in the readings for the numerator or the denominator, always toward an increase.

This method would appear not quite complete if it were not supported by proper calculations giving a real picture of the size of the retinal blind strips.

The method of reckoning the diameter of the retinal blind strips according to angioscotograms may be understood from figure 2 (horizontal section of the eye), in which D_1 indicates the fovea centralis; OC_1 , radius of 10.2 mm.; E , the nodal point, 6.4 mm. distant from point O (according to Werbitzky's reduced eye); MN , the campimeter; D , the fixation point; ACB , the location of the angioscotoma, showing the size of its diameter, and $A_1B_1C_1$, the location of the retinal blind strip.

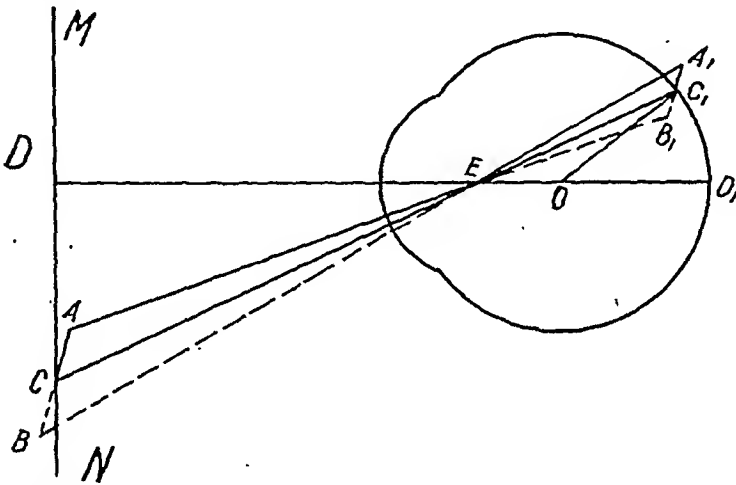


Fig. 2.—Method of reckoning the diameter of the angioscotomas. D_1 indicates the fovea centralis, OC_1 , radius of 10.2 mm.; E , the nodal point, 6.4 mm. distant from point O ; MN , the campimeter; D , the fixation point; ACB , the location of the angioscotoma, showing the size of its diameter, and $A_1B_1C_1$, the location of the angioscotoma.

The triangles AEB and A_1EB_1 are isosceles triangles with equal angles at the summit E . Thus their bases are strictly proportional to their heights. The base A_1B_1 represents the diameter of the blind strip (to be defined) and equals X ; the base of the second triangle, AB , is equal to the size of the smallest white test object (measured in millimeters) which disappears totally for only an instant from the visual field in the corresponding place of the angioscotoma. It remains to define the height of each triangle, CE and EC_1 . Figure 2 shows that these values will change in accordance with the angle CED or the distance CD between the scotoma and the center of the campimeter. This is obvious, as it is known that the greater the distance from the center of the campimeter the more the linear size of the degree changes, and that scotomas of practically equal dimensions will appear different,

if one of them is located near the center and the other much farther away. If one recognizes that the distance ED from the nodal point E of the eye to the center D of the campimeter equals 1,000 mm., then

$$EC = \frac{ED}{\cos \angle CED} = \frac{1.000}{\cos \angle CED} \text{ (formula 1).}$$

As regards EC , the reckoning is made according to the formula for the sines of the oblique triangles:

$$\begin{aligned} \frac{6.4}{10.2} &= \frac{\sin \angle OC_1E}{\sin \angle OEC_1}; \sin \angle OC_1E = \frac{6.4 \sin \angle OEC_1}{10.2}; \\ \angle C_1OE &= 180^\circ - (\angle OC_1E + \angle OEC_1); \\ EC_1 &= \frac{10.2 \sin \angle COE}{\sin \angle OEC_1} \text{ (formula 2).} \end{aligned}$$

After EC and EC_1 are defined, the reckoning of the width of the angioscotoma in the corresponding place is made according to formula 3:

$$\begin{aligned} \frac{A_1B_1}{AB} &= \frac{EC_1}{EC}; \\ A_1B_1 &= \frac{AB \cdot EC_1}{EC} = AB \cdot \frac{EC_1}{EC}. \end{aligned}$$

Assuming that $\frac{EC_1}{EC} = K$, one writes $A_1B_1 = AB \cdot K$ (formula 3),

in which A_1B_1 is the width of the retinal blind strip, AB the size of its projection on the campimeter and K a coefficient which changes in accordance with the distance of the angle of the corresponding portion of the scotoma from the center of the campimeter.

I reckoned a table of values for K and for the size of diameter of the retinal blind strip compared with the size of the test object. The values for the diameters of retinal blind strips are shown in microns. Examination by aid of different contrast test objects will show not only the presence or the absence of the optical function of the retina but also its various stages.

When using a white test object one examines the retina and finds defects of the visual field, after measuring the size of this defect one can say only that the optical function of the retina is absent in the corresponding place.

As regards the condition of the retinal elements localized in the immediate vicinity of the already examined defect of the visual field for white light, such examination gives no results. But when, using my method of examination of an angioscotoma, a blind patch or any other defect of the visual field, one applies not a white but a gray test object, one will naturally obtain greater dimensions of defects. For instance, if when measuring the blindspot one finds that the diameter equals on the campimeter 90 mm. with a white test object and 95 mm. with a gray test object, this will show that the retinal function is lowered at some distance around the optic disk. It is known that in normal eyes a so-called relative blind zone exists around the blindspot; hence it is

obvious that a certain divergence in the results of measuring the blind-spot with white and gray test objects will be a physiologic one. But all readings which surpass the mean values of such divergence will appear to indicate a pathologic condition, and other readings on the campimeter, for instance, 90 and 120 mm., will show the presence of peripapillary retinal inflation.

Likewise, if on examination of an angioscotoma one finds that the size of the white object the image of which disappears in it equals 7 mm. and that of the large object equals from 8 to 9 mm., this small difference will be a physiologic one. But if the corresponding data

TABLE 1.—*Values for Diameter of Retinal Blind Strip Compared with Size of Test Object, Microns*

Size of Test Objects, Mm.	Distance from Center, Degrees						
	0	5	10	15	20	25	30
	Coefficient (K)						
	0.01660	0.01649	0.01619	0.01569	0.01502	0.01417	0.0313
1	16.5	16.5	15.2	15.7	15.0	14.2	13.2
2	33.2	33.0	32.4	31.4	30.0	28.3	26.4
3	49.8	49.5	48.6	47.0	45.0	42.5	39.6
4	66.4	66.0	64.8	62.8	60.1	56.7	52.8
5	83.0	82.5	81.0	78.5	75.1	70.9	66.0
6	100.0	99.0	97.0	94.0	90.0	83.0	79.0
7	116.0	115.0	113.0	110.0	105.0	99.0	92.0
8	133.0	132.0	130.0	126.0	120.0	113.0	106.0
9	149.0	148.0	146.0	141.0	135.0	126.0	119.0
10	166.0	165.0	162.0	157.0	150.0	142.0	132.0
12	199.0	198.0	194.0	188.0	180.0	170.0	158.0
14	232.0	231.0	227.0	220.0	210.0	198.0	185.0
16	266.0	264.0	259.0	251.0	240.0	227.0	211.0
18	299.0	297.0	291.0	282.0	270.0	255.0	237.0
20	332.0	330.0	324.0	314.0	300.0	283.0	264.0
25	415.0	412.0	405.0	392.0	376.0	354.0	325.0
30	498.0	495.0	485.0	470.0	451.0	425.0	396.0
35	581.0	577.0	567.0	549.0	526.0	496.0	462.0
40	664.0	660.0	648.0	628.0	601.0	567.0	528.0
45	747.0	742.0	728.0	705.0	676.0	638.0	594.0
50	830.0	825.0	810.0	785.0	751.0	709.0	660.0

are, for instance, 7 and 17 mm., respectively, this will show that in the course of the retinal vessels there exists a band-shaped defect of the visual field of another kind, namely, that the white test object is differentiated in the denoted retinal zone and the gray test object is not differentiated there on account of the lowered retinal function.

In such cases one can assume the probable presence of perivascular retinal inflation. A much higher dimension of the defects, for instance, 45 mm. with white test objects and 75 mm. with gray test objects, will show that there is retinal inflation along the course of the vessel, linked to the vessel by its origin, and of such a high degree that an absolute band-shaped scotoma is formed. This scotoma is of a considerable width, and at each side there is a relative scotoma, corresponding to the area of lesser intensity of the retinal inflation.

To define the physiologic dimensions of the blindspot Dr. M. L. Kalkutina made, on my request, an angioscotometric examination of one hundred healthy eyes, mostly emmetropic. Only a small number had slight anomalies of refraction. This material was studied by the method of variational statistics. Thus were defined the mean dimensions for the physiologic scotomas of a normal eye. These dimensions were reckoned for three checking points (*BS*, *AS* and *ASm*) and specially for a white test object. The differences in the results of the angioscotometric examination with gray and with white test objects were reckoned.

The results obtained are shown in tables 2 and 3.

With the use of a table prepared for campimetric examinations at a distance of 1 meter (table 1) it was easy to find out if the obtained mean

TABLE 2.—*Diameter of the Blindspot and of Angioscotomas, Obtained with White Test Objects*

	Mean, Mm.	Variation, \pm , Mm.
BS.....	84.5	6.3
AS.....	7.1	1.3
ASm.....	2.3	0.5

TABLE 3.—*Differences in Angioscotometric Readings Obtained by Examination with Gray Test Objects and Those Obtained by Examination with White Test Objects*

	Mean, Mm.	Variation, \pm , Mm.
BS.....	6.6	2.0
AS.....	2.3	0.5
ASm.....	1.6	0.3

dimensions of the blindspot and the angioscotomas correspond to the size of the optic disk and of retinal vascular trunks.

With the aid of this table the following results were obtained:

The horizontal diameter of the blindspot equals 85 mm.; this corresponds perfectly with the real dimensions of the optic disk (1.35 mm.). The diameter of an angioscotoma corresponding to one of the large vascular trunks measures approximately 7 mm., and the diameter of this vessel 110 microns. The diameter of the macular angioscotoma measures also approximately from 2 to 3 mm.; hence the caliber of the large macular vessel is from 31 to 45 microns.

According to Hess and other authors, the vascular trunks in the region of the optic disk have variable calibers, but their mean size equals 100 microns.

Thus the mean dimensions obtained for physiologic scotomas perfectly correspond with the quantitative anatomic correlations in the eye. For the blindspot the difference between the limit determined with a

white test object and that determined with a gray test object generally does not surpass from 8 to 10 mm. For the diameter of an angioscotoma and that of the vascular trunk the difference does not surpass from 2 to 3 mm.; for the macular branch this difference generally equals from 1 to 2 mm. Thus, on the basis of the results of the investigations just described, it is possible in the examination of any patient to make, in the first place, deductions concerning the functional conditions of his retina, utilizing for this purpose the diameter of the blindspot and of the angioscotomas, obtained with white and gray test objects.

The investigations were divided into two principal groups. The first group represents experimental investigations for the definition of the cardinal question, namely, the character of the angioscotomas. The second group represents the clinical study of eyes with various pathologic processes and angioscotometric examination of the persons with perfectly normal visual organs but suffering from disturbed circulation of the spinal fluid (high intracranial tension) and circulation of the blood (in stages of perfect compensation and in various degrees of sub-compensation or decompensation).

EXPERIMENTAL PART

I selected for my experiments three patients with emmetropic eyes and visual acuity always of 1.

EXPERIMENT 1 (Patient K).—Pressure was exercised on one eye. The diameter of the blindspot of the angioscotomas of the second eye were measured before pressure, during pressure and immediately after pressure until all dimensions of the blindspot and of the angioscotomas returned to their initial extent. When pressure was exercised on one eye, the reactive hypertension in the other eye produced enlargement of the blindspot and of the angioscotomas. Table 4 shows the course of the changes produced by transitory reactive hypertension of the eye.

The blindspot had remained practically unchanged in diameter with the white test object and also with the gray test object. Its enlargement remained extraordinarily slight. The angioscotomas did not undergo considerable changes. The maximal enlargement of the diameters of the scotomas with the white and the gray object appeared seven minutes after the beginning of pressure and remained unchanged for from three and one-half to four minutes until the end of pressure. Three and one-half minutes after the end of pressure the dimensions of the angioscotomas became normal.

EXPERIMENT 2.—To prove the affirmations of various authors as to the presence of an indubitable connection between the lymphatic circulation in the nose and that in the posterior part of the eyeball I repeated the experiment of Evans: the stopping of nasal breathing. The nose of patient K was filled with tampons; she breathed calmly with her mouth open, and I made on the campimeter the measurement of the blindspot and of the angioscotomas. No changes in the diameter of the blindspot occurred (table 5). The angioscotomas showed no enlargement when examined with white test objects and a slight enlargement when examined with gray test objects.

This experiment lasted thirty minutes. Then the nasal breathing was resumed. After seven and one-half minutes the diameter of the angioscotomas showed their initial measurements.

TABLE 4.—Changes in the Diameter of the Blindspot and of the Angioscotomas in One Eye When Pressure Was Made on the Other (Examination of Right Eye of Patient K) *

Region Examined	Diameter Before Experiment	Time, Minutes									
		0	2	4	5	7	9	10½	11½	13	14
BS	80/96	Beginning of Pressure on Left Eye	..	..	..	..	85/96	Pressure Discontinued	...	..	80/06
AS	6/12		7/15	..	9/17	9/17	9/17		...	7/15	6/12
ASm	2/6.5		..	4/10	..	6/14	6/14		3/9	..	2/6

* The dimensions of the angioscotomas corresponding to branches of smaller macular vessels (ASm) and those corresponding to larger vascular trunks (AS) showed on the day of the determinations (rhinitis subacuta) enlargement for the gray test object. Since the limits for the white test object remained normal, this did not hinder the experiment.

TABLE 5.—Changes in the Diameter of the Blindspot and of the Angioscotomas with Stopping of Nasal Breathing (Examination of Right Eye of Patient K)

Region Examined	Diameter Before Experiment	Time, Minutes													
		0	3	5	8	12	15	26	31	33	34	36	38	39½	41
BS	80/96	Beginning of Stopping of Nasal Breathing	....	....	....	...	80/96	....	80/96	Unobstructed Nasal Breathing	....	...	....	....	80/92
AS	6/12		6/13	6/15	6/18	...	....	6/18	6/18		6/16	...	6/15	6/13	6/12
ASm	2/6.5		....	2/8	....	2/9	....	2/9	2/9		....	2/8	2/7	2/7	2/6

TABLE 6.—Changes in the Diameter of the Blindspot and of the Angioscotomas with Total Stopping of Breathing (Examination of Right Eye of Patient K)

Region Examined	Diameter Before Experiment	Ex-periment, Mm.	Breath-ing Stopped for 30 Sec.	Time After Breathing Was Resumed, Seconds									
				5	15	30	40	50	60	70	80	90	100
BS	4	7	6	..	..	5	..	..	..	..	..	4	..
AS	2	6	..	5	..	..	4	..	3	..	..	..	2
ASm	1	4	..	3	3	..	..	2	..	..	..	1	..

EXPERIMENT 3.—To produce congestion in the eye I totally stopped the patient's breathing for thirty seconds. The measurement of the angioscotomas was made between twenty-five and thirty seconds. On account of lack of time no measurements of the blindspot were made, but only those of the angioscotomas at three points. Their enlargement was marked. Then breathing was resumed, and the moment was defined when the diameter of the angioscotomas became normal at all the points of observation. As it was not possible to make the investigation with more than one test object, I used only the white test object.

In all three points the dimensions of the angioscotomas became normal after from ninety to one hundred seconds. Then I investigated only the blindspot also for thirty seconds, during the stopping of breathing, and defined the moment when its dimensions became normal. It was measured with white and gray test objects (table 7).

EXPERIMENT 4.—I made one more experiment by interrupting the return of the venous blood from the head. I put the cuff of a Riva-Rocci apparatus on the neck of the patient and pumped air. This pressure (from 70 to 75 mm. of mercury) produced considerable reddening of the face.

The retention of the venous blood occurred at the cost of the compression of the skin and jugular veins. Subjective changes occurred: difficulty in breathing, palpitation of the heart, the sensation of a rush of blood to the head (a feeling as if the head was bursting) and temporal pulsation. No subjective visual changes

TABLE 7.—*Changes in the Diameter of the Blindspot with Total Stopping of Breathing*

Test Object	Time Before Experiment	Breathing Stopped for 30 Sec.	Time After 55 Sec.	Time After 65 Sec.
White.....	90	96	90	90
Gray.....	98	105	..	98

TABLE 8.—*Changes in the Diameter of the Blindspot and of the Angioscotomas in Cases of Hampered Reflex of Blood from the Head*

Region Examined	Diameter Before Experiment	Time, Minutes												
		0	2½	6	7½	9	12	13	13½	14½	15	16	18	20
BS	80/96	Beginning of Pressure on Veins of Neck	....	....	....	....	80/96	....	Pressure Discontinued	....	...	....	....	80/96
AS	6/12		6/15	6/16	6/20	....	6/20	....		6/18	...	6/16	6/13	6/12
ASm	8/6.5		3/7	....	....	3/10	3/10	3/11		3/10	2/8	2/7	2/6.5	2/6.5

were noted. This experiment showed that the size of angioscotomas became changed also, but not to such a degree as in the preceding experiment. Their diameters remained unaltered when examined with white test objects; changes were observed by examination with gray test objects.

The size of the blindspot remained unchanged. This demonstrates the fact that total interruption of breathing causes much greater congestion than interruption of the return of the venous blood from the head by means of compression of the superficial veins.

Further control experiments, made by special methods, gave very interesting results.

It is known that when one sits in a sulfur bath (H_2S) important changes occur in the system of cardiac vessels. In consequence of expansion of the superficial vessels intense reddening of the skin immediately appears. Its line of limitation is generally located between the parts of the body immersed in water and the outer parts. When the

subject comes out of the bath one often sees on the buttocks, on the parts of contact when sitting, two white patches on a red background. These are the parts of the body which did not come in contact with sulfurated hydrogen (H_2S). During such a bath there occur an afflux of blood into the peripheral sections of the blood vessels and a reflux from the interior organs and the brain.

Three and one-half minutes afterward the skin generally turns paler. The peripheral vessels commence to contract, and the inner organs receive the blood which during bathing flowed out into the peripheral vessels.

EXPERIMENT 5.—My aim was to trace the changes in the retinal vessels under the influence of a sulfur bath (H_2S). For this purpose I used the Gullstrand ophthalmoscope with a modification, namely, placing in the ocular tube of a special prism with 3 mm. openings in its center. This permitted me to make a fairly precise measurement of the caliber of the vessels and to express the data in microns.

When I examined the eyeground I saw two images, one through the opening in the prism and the other produced by the light rays which passed through the prism and were refracted at an angle corresponding to the strength of the prism.

As I already knew the refraction power of the prism and the magnifying power of the apparatus, I was able to measure the caliber of the vessels with sufficient precision.

I fixed an arrow on the ocular part of the apparatus and a stationary graduated disk in front of it. Knowing for how many degrees I turned the ocular tube each time, I could reckon the refraction power of the prism. When the vessel being examined appeared as a double one, I turned the prism till the borders of the two images of the same vessel came in contact. At that time the red strip in the ocular field corresponding to the vessel being examined appeared twice as wide as a single vessel. The location of the arrow was marked in degrees on the disk. Then one image of the vessel was transferred to the other side of the principal image and once more drawn together with the latter till their borders again came into contact, but on the other side. Then the location of the arrow was again marked. The angle of refraction divided into halves gives the corresponding value of the angle the sine of which equals the caliber of the vessel (fig. 3). Then I made the necessary reckonings in accordance with the refraction power of the prism and the magnifying power of the apparatus. One may not make such reckonings for the comparative values; the caliber of the vessel may be shown in degrees of the angle of refraction of the prism.

The experimental patients, B. and C., were placed in a sulfur bath (H_2S), and the measurement of the vessels was made before entering the bath and after coming out of the bath. Table 9 shows objectively in degrees of the angle of refraction of the prism considerable dilatation of the retinal veins and arteries under the influence of the sulfur bath (H_2S).

I also made angioscotometric examinations of these patients. A small campimeter was fixed on the bath; a board with a special rest for the chin of the experimental patient was put across the rims of the bath; the patient was placed in the empty bath, and an accurate angioscotometric measurement was made. Preliminary examination was made under the usual laboratory conditions. The results obtained were analogous.

Thereupon the bath was half filled with water and a sulfurated hydrogen compound put into it. Angioscotometric examinations were made every minute. The results are shown in table 10.

Two minutes after the patients entered the bath the angioscotomas of each were considerably contracted; this was attributed to the diminishing of the caliber of the retinal vessels. This contraction lasted only six minutes. Four and one-half minutes later the retinal vessels of the first patient, and, after almost the same period, those of the second, showed the initial dimensions of their calibers. The dilatation of the vessels appeared rather soon and was of a high degree.

Ten minutes after taking the bath each patient was examined under laboratory conditions with the usual campimeter and the white and gray test objects.

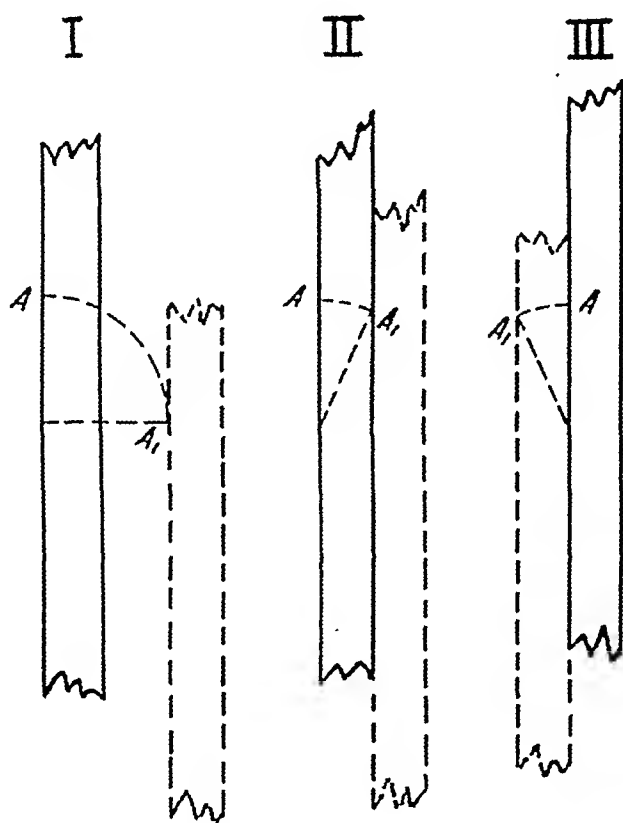


Fig. 3.—Method of measuring the caliber of retinal vessels. *I* shows two images obtained with a prism. *II* shows the borders of the images brought into contact. *III* shows the images brought together on the opposite side. The angle of refraction divided into halves gives the value of the angle the sine of which equals the caliber of the vessel.

After the bath the examination of the first patient was continued during seven, and that of the second patient during five, hours. The blindspot and the angioscotomas showed a tendency to diminish in dimension only after an interval of five hours.

It is interesting that during approximately two hours the difference in the results of the examination with white and gray objects was 0 or slightly higher; afterward this difference became greater and lasted until the end of the examination.

An explanation of this fact may be that on account of protracted dilatation of the vessels and their greater porosity the permeability of the walls becomes greater, there is greater interchange between the vessels and the adjacent tissue, and the transudation is prevalent. The presence of fluid behind the walls of the vessels in the perivascular

TABLE 9.—Changes in the Diameter of the Caliber of the Retinal Veins and Arteries Produced Under the Influence of a Sulfur (H₂S) Bath, Degrees

Vessel	Patient B.					Patient C.				
	Degrees Before Entering Bath	Time After Coming Out of Bath				Degrees Before Entering Bath	Time After Coming Out of Bath			
		21 Min.	3 Hr., 15 Min.	4 Hr., 15 Min.	5 Hr., 15 Min.		1 Hr., 30 Min.	3 Hr.	5 Hr.	6 Hr.
Vein.....	15	21	20	21	15	25	30	26.5	27	26
Artery.....	10	15	15	14	11	12.5	13.5	17.5	16.5	15.5

TABLE 10.—Changes in the Diameter of the Blindspot and of the Angioscotomas Produced Under the Influence of a Sulfur (H₂S) Bath

Region Examined	Before Experiment	Patient B													
		Time When Patient Was Sitting in Bath				Time After Coming Out of Bath									
		2 Minutes	3 Minutes	4 Minutes	6 Minutes	3 Minutes	4 Minutes	5 Minutes	17 Minutes	30 Minutes	1 Hr., 10 Min.	2 Hours	3 Hours	4 Hours	5 Hours
BS	88/98	..	..	..	..	..	..	90/100	90/100	92/105	100/115	97/110	100/115	95/110	
AS(1)†	15*	..	..	..	..	..	..	.....	22	30	40/42	40/50	40/50	35/45	
AS(2)†	7*	4	4	4	4	4	5	6	8	10	12	23	20/25	18/22	17/20

Region Examined	Before Experiment	Patient C									
		Time When Patient Was Sitting in Bath				Time After Coming Out of Bath					
		2 Min.	3 Min.	4 Min.	6 Min.	25 Min.	20 Min.	1 Hr., 40 Min.	2 Hr., 40 Min.	4 Hr., 40 Min.	6 Hr., 50 Min.
AS (1)	6*	6	6	5	4	12	15	20/25	30/37	28/35	
AS (2)	5*	4	4	4	3	8	8	8/11	9/13	9/13	
ASm	3*	3	2	1	1	5	5	5	5	4	

* White test object only.
† AS(1) is AS determined on the radius of the campimeter located 45 degrees upward, and AS(2) is AS determined downward from the horizontal line.

space accounts for the appearance of the wide scotomas for gray test objects.

Comment.—The results of the angioscotometric examination and of the measurement of the retinal vessels with the Gullstrand ophthalmoscope and my device were identical. These experimental data corroborate the statements of Evans, Samoylov and Magitot that the angioscotomas are the shadows of the retinal vessels and the lymphatic perivascular spaces.

CLINICAL PART

In accordance with Evans, Dimshitz and Magitot, I observed even in my first investigations that in certain diseases the changes of the blindspot and the angioscotomas are expressed in an extraordinarily high degree. I examined during 1935-1936 over six hundred patients with ocular diseases of various etiology. I made these investigations chiefly in cases of glaucoma, retrobulbar neuritis, neuroretinitis, choked disks, increased intracranial tension with suspected tumor of the brain and diseases of the meningeal membranes. In all these cases the blindspot and the angioscotomas showed great changes. In patients with glaucoma I always found an enlarged blindspot (Bjerrum's scotoma) and enlarged angioscotomas. To ascertain if glaucoma really appears as a factor producing enlargement of the blindspot and of the angioscotomas I applied the pilocarpine test and measured the angioscotomas from every half hour to one every hour. The statement of Samoylov on the specific character of this test for glaucoma was corroborated. After the instillation of pilocarpine hydrochloride into the glaucomatous eye the dimensions of the blindspot and of the angioscotomas appeared diminished when examination was made with white and gray test objects. In normal eyes and in cases of other diseases the instillation of pilocarpine hydrochloride does not produce such an effect.

The advantage of the pilocarpine test used with my angioscotometric method is that the normal dimensions of the blindspot found with white test objects may be much larger when examined with gray objects. Thus, in cases in which the blindspot appears of normal size as examined with the usual methods, scotometry with the use of different contrast test objects reveals enlargement. In such cases the positive result of the pilocarpine test indicates the presence of glaucoma of the prodromal stage. The parallel examination of the dimensions of the angioscotomas in one or two points completes the examination and helps one to make a diagnosis in dubious cases.

PATIENT R.—During the three months previous to examination the visual field of this patient, aged 56 years, had grown dim. Vision of the right eye was 1, and that of the left eye was 0.1. The visual fields were not contracted. The anterior part and transparent media of each eye were normal. The eyeground of the right eye was normal; that of the left eye showed excavation. There was gray atrophy of the optic disk. The intra-ocular tension of the right eye was 28 mm. of mercury, and that of the left eye was 55 mm. Dark adaptation was lowered in each eye. The results of angioscotometric examination combined with the pilocarpine test are shown in table 11.

The diagnosis was glaucoma of the prodromal stage of the right eye and chronic glaucoma of the left eye.

PATIENT X.—This patient, aged 47 years, had a rather asthenopic condition which might indicate symptoms of glaucoma of the prodromal stage. Vision of each eye was 1. The eyegrounds were unchanged. The visual field showed

great distance between isopters (as determined with 10 and 3 mm. white test objects) in the upper nasal part (in the right eye in a greater degree than in the left eye). In the right eye the blindspot and the angioscotoma were enlarged. Dark adaptation of each eye was normal. The results of the Valsalva test were doubtfully positive for the right eye and negative for the left eye. The results of angioscotometric examination combined with the pilocarpine test were positive for the right eye and negative for the left eye.

In diseases of the optic nerve and on account of the inflammations of the tissue of the nerve trunk, the central retinal vessels are often contracted. First the perivascular lymphatic spaces become contracted;

TABLE 11.—*Results of Angioscotometric Examination Combined with the Pilocarpine Test (Patient R)*

Before Pilocarpine Test		After Pilocarpine Test					
		½ Hr.	1 Hr.	1½ Hr.	2 Hr.	2½ Hr.	3 Hr.
Right Eye							
BS	100/120	88/105	78/95	70/88	70/80	74/92	85/105
AS	20/35	15/27	11/24	10/18	12/15	15/22	16/30
ASm	10/18	6/11	4/8	3/6	3/7	6/10	9/16
Left Eye							
BS	135/175	120/150	110/135	98/20	85/105	88/115	95/135
AS	35/55	25/35	28/30	18/25	13/20	16/25	20/35
ASm	12/25	8/18	6/12	5/10	4/10	5/14	10/20

TABLE 12.—*Results of Angioscotometric Examination Combined with the Pilocarpine Test*

Before Pilocarpine Test		After Pilocarpine Test			
		1 Hr.	2 Hr.	3 Hr.	3½ Hr.
Right Eye					
BS	100/125	84/97	74/90	70/80	78/92
AS	30/60	22/46	15/25	10/13	15/25
ASm	7/17	4/2	3/10	4/13	6/14
Left Eye					
BS	95/100	95/100	95/100	95/100	95/100
AS	8/10	7/9	7/9	7/9	7/9
ASm	2/4	2/4	1/4	2/4	2/4

this produces lymphatic congestion. Slight congestion in the region of the optic disk caused by external squeezing (pressure) on the nerve or by inflammation of the nerve trunk suffices to disturb the lymphatic circulation in the lymphatic spaces and to produce lymphatic congestion along the course of the retinal vessels. The congestion, i. e., the retinal inflation, is shown at once on the campimeter by enlargement of the diameters of the angioscotomas when measured with gray test objects.

Thus angioscotometry with different contrast test objects permits one to define the earliest stages of a lymphatic disorder in the posterior part of the eyeball. But this examination and the produced enlargement of the blindspot and of the angioscotomas are still insufficient for a diagnosis.

When such examinations are complemented with a study of the visual field (by perimetric, campimetric or stereocampimetric examination) and there are found changes in the form of concentric contraction of the visual field in cases of retrobulbar neuritis or in the form of a central scotoma associated with axial neuritis, one may often with a perfect assurance diagnose axial or peripheral retrobulbar neuritis, even if no changes in visual acuity are present.

PATIENT SH.—This patient, a woman aged 31 years, suffered from influenza. Some days later she noted hazy vision in the right eye, and a disagreeable feeling. Acuity of vision of the right eye was 1; the eyeground was normal. Perimetric examination showed concentric contraction of the visual field. Campimetric examination revealed that the blindspot and the angioscotomas were enormously enlarged. The diagnosis was *perineuritis retrobulbaris postgripposa*. Further observation corroborated this. After two and one-half months the symptoms ceased and the patient was discharged.

PATIENT O.—This patient, a woman aged 26 years, showed no changes in the left eyeground, but visual acuity of the left eye was reduced to 1/10. Visual acuity of the right eye was 1. The limits of the right visual field, as determined with 10 mm. and 3 mm. test objects, were normal. There was slight divergence of the isopters. The visual color field was normal. The blindspot and angioscotomas were not enlarged.

Clinical examination of the left eye showed only reduced visual acuity—1/10. Functional examination revealed that the left visual field was concentrically contracted, with considerable divergence of the isopters. In correspondence with the contraction of the visual field, the field for color was also contracted, but only slightly. The blindspot was enlarged, its dimensions being from two to three times larger than normally. There were rather large angioscotomas.

The patient returned after some days. Visual acuity of the left eye was 0.7. She said that on the first day of her visit she had a second attack of influenza. Functional examination showed increase of visual acuity of the left eye and a normal visual field. The blindspot was greatly diminished in size. The angioscotomas were considerably contracted, their dimensions being almost normal.

The diagnosis was *perineuritis retrobulbaris gripposa*.

In patients with papillitis of various etiology, as in cases of retrobulbar neuritis, enlargement of the blindspot and of the angioscotomas were found. Such changes were observed also in cases of choked disks. Therefore the angioscotometric method cannot serve as the only means of differential diagnosis between choked disks and inflammation of the optic nerve (papillitis and retrobulbar neuritis).

When patients are directed by neuropathologists for examination of the eyegrounds, angioscotometric examination appears to be a great help in cases of increased intracranial tension.

When in cases of refractory and protracted headaches, with a normal picture of the eyegrounds, visual acuity of 1 and a total absence of changes in the field, one finds enlargement of the blindspot and of the angioscotomas, or even normal dimensions as determined with white test objects, and one finds increased dimensions as determined with gray

test objects, one might, almost with perfect certainty, make the statement that the intracranial tension is increased.

Of course, many other factors which may cause enlargement of the blindspot and of the angioscotomas must be excluded. A large percentage of the conclusions regarding, and the diagnosis of, increased intracranial tension by my associates and me were afterward corroborated by neurologic and roentgenologic examinations. This is illustrated by the following cases:

PATIENT K.—During many months there had been refractory and severe headaches. There was total absence of any decrease of visual acuity or changes in the eyeground and of any convincing data based on the neurologic examination. However, examination showed concentric contraction of the visual fields. The increased intracranial tension was corroborated by neurologic examination some time afterward.

PATIENT M.—This patient, aged 22 years, suffered from influenza and constant headaches. The internal organs were normal, as were the accessory sinuses. Visual acuity was 1. The eyeground of each eye was normal. The visual fields were normal. The blindspots and angioscotomas were enormous.

The diagnosis was increased intracranial tension caused by meningitis serosa postgripposa chronica.

The neuropathologic diagnosis was meningitis serosa chronica. Roentgenologic examination showed also increased intracranial tension. A large number of patients who were directed to the ophthalmic institute from clinics for patients with psychoneurologic and nervous conditions associated with proved tumor of the brain showed without exception enlargement of the blindspot and of the angioscotomas, and a great difference in the dimensions of the blindspot and of the minute macular branches when measured with white and gray test objects.

I examined with Dr. S. S. Scheinkman many rheumatic children with deranged circulation of the blood. Complete clinical examination of these children was made by a pediatrician, a rhinologist, a roentgenologist and an ophthalmologist. All the patients with deficiency of circulation of the blood showed enlargement of the blindspots and of the angioscotomas. The dimensions of these scotomas became smaller after treatment.

In cases of insufficiency of circulation of the blood a rise of the hydrostatic tension in the venous part of the capillaries was present (Strazhesko). The products of water metabolism are not entering or almost not entering into the blood. One may expect diffuse inflation of the retina. But this does not occur in patients with symptoms of decompensation or subcompensation; I always found only enlargement of the blindspot and of the angioscotomas. In his article on the pathogenesis of the inflation Strazhesko said that the lymphatic system generally starts to substitute for the reflux of the vascular system when the function of the latter is deranged. It is thus obvious that in cases of noncompensated derangement of the circulation of the blood perivascular and peripapillar retinal inflation is met with.

In this way angioscotometric examination in many cases shows the changes of the physiologic scotomas. Enlargement of the blindspot and of the angioscotomas may be present in cases of glaucoma, diseases of the optic nerve, increased intracranial tension, derangement of the circulation of the blood and other conditions. The change of the angioscotometric index can be observed even in the initial stages of these diseases.

Hence it is obvious that the method of angioscotometry with different test objects, which I proposed, cannot be used as an independent method for functional diagnosis. It is a valuable auxiliary method and may be very helpful when one is considering all the findings of the clinical examination with the aim of excluding a series of factors causing enlargement of the blindspot and of the angioscotomas.

SUMMARY

The proposed new method for the measurement of the blindspot and of the angioscotomas permits one to make a more precise quantitative judgment of the changes in the scotomas than it was possible to do formerly. Exact measurement of the angioscotomas is made possible for the first time.

When measuring the dimensions of the physiologic scotomas by this new method, it is not necessary to make detailed sketches of their contours; this method permits prompt sketching of the outline of the blindspot and of the angioscotomas.

Angioscotometry with the use of a combination of different contrast test objects transforms the proposed method into a clinical one, which defines the functional condition of the retina in peripapillar and perivascular spaces. It permits one to know at once if there is a normal or a pathologic correlation between the blood and lymphatic systems and the retinal tissue.

It is possible by this new method to find pathologic correlations in cases in which with the usual Bjerrum's campimetry a blindspot of normal dimensions is observed.

Angioscotometric examination combined with the pilocarpine test has great advantages over the usual method; it offers a greater possibility of obtaining positive results in cases of glaucoma of the prodromal stage.

The application of different contrast test objects permits one to make a more detailed study of the functions of the eyes in cases of derangement of the circulation and of the lymph of the blood. This method is of importance not only in ophthalmology but also in general medical practice.

Finally, it permits study of the influence of various pharmacologic remedies on the circulation of the blood and lymph of the eye.

PRECANCEROUS MELANOSIS AND DIFFUSE MALIGNANT MELANOMA OF THE CONJUNCTIVA

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The fact that tissue may undergo certain changes prior to the development of a malignant growth is well known. A precancerous stage of varying duration has been observed in the experimental production of epithelioma in animals. In human beings such instances are afforded by the senile dystrophy of the skin which manifests itself by atrophy, degeneration of elastic tissue, flecks of pigment, telangiectasis and circumscribed keratosis. The same changes are seen in xeroderma pigmentosum. Other conditions in which such changes occur are leukoplakia, extramammary Paget's disease and Bowen's disease. Among these rarer manifestations can be mentioned also melanosis of the skin and of the conjunctiva.

In dermatology this is recognized as a precancerous change, and considerable is known about its clinical and histologic characteristics. It may appear in the skin anywhere over the body but has a predilection for the face. It is a rather diffuse nonelevated pigmentation in an otherwise normal appearing skin. It is of a granular appearance, the granules becoming confluent to form more or less dense sites of pigmentation. The average time between the appearance of this melanosis and the occurrence of malignant changes in it is about ten years. The period may be longer or considerably shorter, so that at times the melanosis becomes malignant almost ab initio. The average age at which it appears is 40 years. Miescher¹ reported that of thirty-five malignant melanomas of the skin, fifteen arose from a nevus, ten from normal skin and ten from precancerous melanosis. A similar precancerous melanosis may occur in the conjunctiva and be the forerunner of a diffuse malignant melanoma. Eight such cases are reported here.

Read in part at the meeting of the American Ophthalmological Society, Hot Springs, Va., June 3, 1937.

From the Institute of Ophthalmology and the Memorial Hospital for the Treatment of Cancer and Allied Diseases.

1. Miescher, G.: *Geschwülste der Haut*, in Jadassohn, J.: *Handbuch der Haut- und Geschlechtskrankheiten*, Berlin, Julius Springer, 1933, vol. 12, pt. 3, p. 1048.

REPORT OF CASES

CASE 1.—F. R. L., a man, noticed at the age of 45 some pigment spots in the bulbar conjunctiva of the right eye between 7 and 8 o'clock and only a few millimeters from the limbus. The largest area measured 2.5 mm. in the vertical and 2 mm. in the horizontal diameter. There was no elevation. In addition, there were other diffuse poorly demarcated lightly pigmented granular appearing areas, particularly below between 6 and 7 o'clock. The conjunctival vessels leading to the aforementioned areas were somewhat congested. Three years later the main lesion was excised, as it had become slightly larger. Microscopic examination showed diffuse precancerous changes with questionable signs of an early malignant melanoma. Pigmented lesions continued to manifest themselves in this region (fig. 1 *A*), so that two years later irradiation was given, but to no avail. Another local excision was performed, and microscopic examination of a section showed a diffuse malignant melanoma along with precancerous changes of the contiguous conjunctiva. Recurrences followed (fig. 1 *B*). Exenteration was advised, but the patient would not give his consent. The lesion continued to extend, so that in three more years it had spread diffusely over the entire bulbar conjunctiva and most of the palpebral conjunctiva without producing any appreciable elevation or localized tumor formation (fig. 1 *C*). Exenteration was finally done. In four more years papilledema appeared in the left eye, and a relative scotoma developed over the temporal portion of the visual field. The patient died in several months, thirteen years after the appearance of the conjunctival melanosis and eight years after the onset of the malignant growth.

Summary.—There was a diffuse precancerous melanosis of the bulbar conjunctiva for five years prior to the development of a diffuse, almost flat, malignant melanoma, involving ultimately the entire bulbar and palpebral conjunctivae.

CASE 2.—W. W., a man, noticed at the age of 39 a black spot near the inner corner of the right eye. Ten months later, because this spot had increased in size and occasioned some pain and redness, he consulted Dr. John M. Wheeler. In the bulbar conjunctiva of the right eye, between the caruncle and the limbus, was a slightly elevated brownish black mass. The lesion was mainly in the horizontal meridian but extended for some distance superiorly and inferiorly. Surrounding this darkly pigmented tumor was a nonelevated brownish zone of pigmentation. There were three indefinite brownish areas on the nasal aspect of the superior tarsus. The tumor involving the bulbar conjunctiva was excised, and microscopic examination showed a malignant melanoma with precancerous changes in the adjacent conjunctiva. One month later a preauricular gland was noted. The conjunctival tumor spread rapidly, so that in four more months it involved the bulbar conjunctiva almost around its entire circumference and was beginning to appear on the palpebral conjunctiva. In still another two months the tumor occupied the entire circumference of the eye and had extended down into the corneal epithelium from above. There was some bleeding from the tumor. Exenteration of the orbit was done. In six months there were a local recurrence in the outer wall of the orbit and a bluish nodule in the upper skin flap. In two months cervical nodes were palpable, and the orbital recurrence was increasing in size. In one year there were marked loss of weight and pain over the fourth and fifth lumbar vertebrae, which, together with neurologic signs,

indicated spinal metastasis. The patient died two months later, two years and four months after the onset of the condition.

Summary.—There was precancerous melanosis of the bulbar conjunctiva for ten months prior to the development of a diffuse malignant melanoma. The precancerous changes and the melanoma ultimately involved the entire bulbar and palpebral conjunctivae.

CASE 3.—F. I. McB, a man, at the age of 47 first noted a black spot on the temporal bulbar conjunctiva of the left eye. For ten years this remained unchanged, but during the past year it increased in size, and for this reason the patient consulted Dr. John M. Wheeler. Examination showed a dark pigmented mass on the temporal aspect of the bulbar conjunctiva that was roughly triangular in shape with the base at the limbus from 1 to 5 o'clock and extending for a short distance on to the cornea. The apex pointed temporally and ended 12 mm. from the limbus at 3 o'clock. There was some melanosis of the bulbar conjunctiva adjacent to the tumor. There were dilated tortuous conjunctival blood vessels extending to the tumor. Local excision was done one month before the writing of this report, and microscopic examination showed a diffuse malignant melanoma with diffuse precancerous changes in the surrounding conjunctiva. The patient is well and no preauricular or cervical nodes are palpable.

Summary.—There was precancerous melanosis of the bulbar conjunctiva for ten years prior to the development of a diffuse malignant melanoma, with diffuse precancerous changes in the surrounding conjunctiva.

CASE 4.—J. McG., a man, at the age of 67 first noted a pigmented lesion of the right bulbar conjunctiva nasally. Six weeks later he consulted Dr. Franklin Bracken, who found a lesion measuring 6 mm. vertically and 4 mm. horizontally between 2 and 4 o'clock. It was elevated about 2 mm. There was a nonelevated melanosis of the adjacent conjunctiva extending upward as far as 12 o'clock and downward as far as 6 o'clock. Dr. Bracken did a wide excision of the lesion, including the surrounding melanosis. A section of this specimen was not available for examination. After three years a recurrence appeared at 12 o'clock and at 6 o'clock. Excision was done at these two sites by Dr. Bracken, and microscopic examination showed diffuse precancerous changes with localized areas of malignant growth. Dr. James Ewing concurred in the results of the examination. Because of the patient's age, it was elected to try irradiation. The patient was referred to Dr. James Duffy, of the Memorial Hospital, where irradiation with radon in a glass bulb was given to the right eye in the following doses (millicurie minutes with no filter in contact with the lesion):

Date	Mc. Min.
5/24/35	100
7/ 7/35	300
11/20/35	250

The treatments resulted in some regression of the lesions as evidenced by a decrease in the pigment content, but after one year new sites of growth appeared, and during the following year these increased in size and number, so that at the time of the writing of this report there are at the limbus, at 7 and 9 o'clock, flat pigmented areas measuring 2 mm. at the base along the corneal margin and

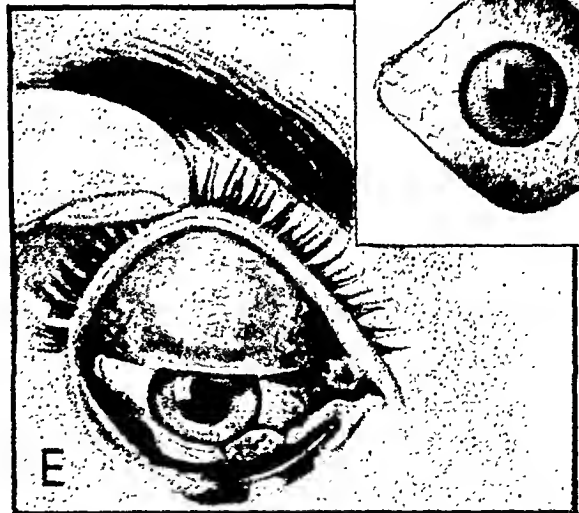
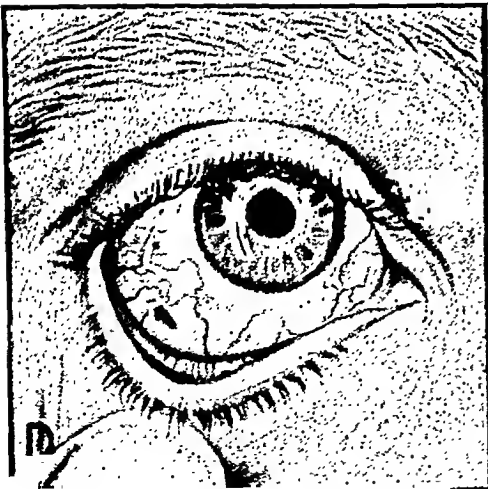
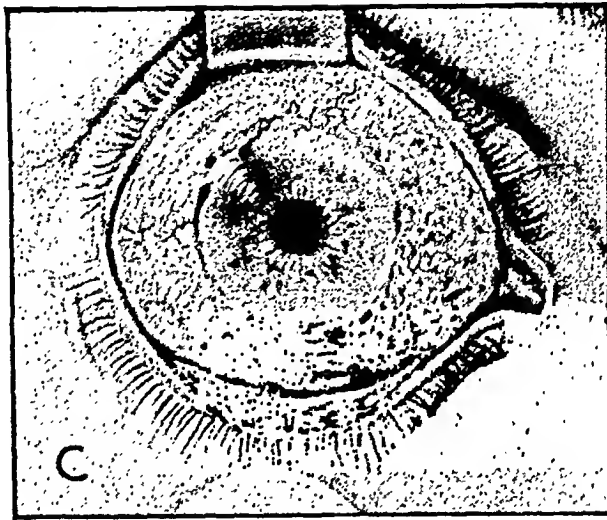
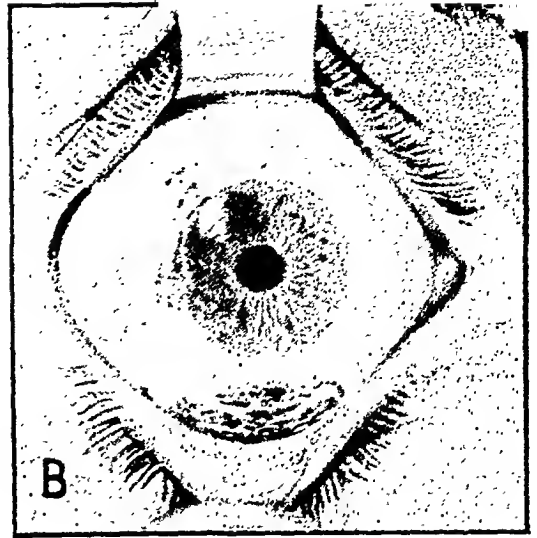
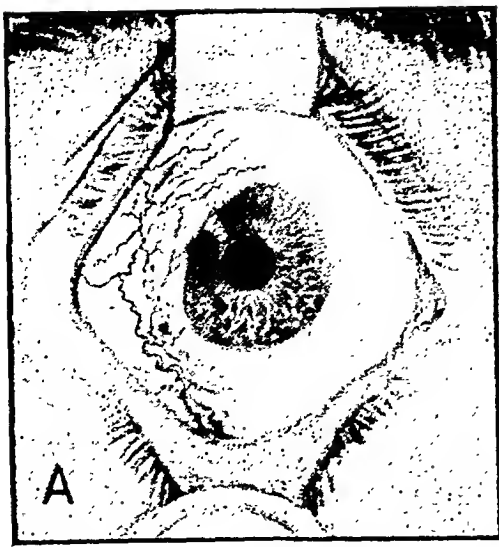


Fig. 1.—*A* (case 1), recurrence after the first excision. *B* (case 1), recurrence after the second excision. *C* (case 1), final extension covering the entire bulbar and palpebral conjunctivae and a portion of the cornea above. The lesion was perfectly flat throughout, with no localized tumor mass at any site. The drawing was made just before exenteration. *D* (case 5), appearance of the lesion just before biopsy and exenteration. *E* (case 8), drawing made with the upper and lower lids everted. The insert shows the extensive involvement of the bulbar conjunctiva. Except for the small localized tumor mass in the lower lid, just nasal to the midline, the lesion showed no elevation.

extending for 1 mm. out into the surrounding bulbar conjunctiva. Above, in the bulbar conjunctiva, at 11 o'clock and from 8 to 10 mm. from the limbus, are several diffuse flat pigmented areas. The patient is well, and there is no evidence of metastasis.

Summary.—A diffuse malignant melanoma developed apparently spontaneously in the bulbar conjunctiva. There was precancerous melanosis around the original malignant site, and it is possible that the melanosis preceded the malignant changes but was unobserved by the patient.

CASE 5.—K. W., a man, at the age of 54 first noted a nonelevated irregularly shaped pigmented spot on the bulbar conjunctiva of the right eye 8 mm. from the limbus at about 9 o'clock. The lesion enlarged slightly, so that three years later, when it was about 2 mm. in size, it was excised. A section of this specimen was not available for study. The patient's attention was again called to this area three years later by the appearance of two pigmented spots in the region where the former one had been excised. These spots had enlarged slightly during the preceding few months. Examination at the Memorial Hospital showed (fig. 1D) two jet black nonraised areas of pigment on the bulbar conjunctiva temporally at between 8 and 10 o'clock and about 3 mm. from the limbus. These measured 2 by 1.5 mm. and 2 by 0.5 mm. There was a smaller lesion above these at about 11 o'clock which measured 2 by 0.5 mm. In the lower portion of the bulbar conjunctiva were several faint light brown diffuse areas of pigmentation. There was no elevation of any of the lesions. The lesions on the bulbar conjunctiva at 8 and 10 o'clock were excised. Microscopic examination of these showed a diffuse precancerous melanosis with signs of an early malignant melanoma in places. The microscopic report was concurred in by Drs. James Ewing, Fred Stewart and Purdy Stout. Exenteration of the orbit was done, and a Thiersch graft was implanted. At the time this report is written, four years after exenteration, the patient is well and there is no evidence of metastasis.

Summary.—There was a precancerous melanosis of the bulbar conjunctiva for six years prior to the beginning of malignant changes. Exenteration was done, and the patient showed no signs of metastasis or local recurrence after four years.

CASE 6.—J. McP., a man, at the age of 55 first noted a pigmentation about the outer aspect of the upper and lower lids of the right eye around the external canthus. This appeared rather suddenly and was not accompanied by symptoms. He thought that it had shown some regression. Four months from the onset he consulted Dr. Hayes E. Martin, who found an irregular nonelevated pigmented lesion of the skin of the eyelids and the adjacent palpebral conjunctiva at the outer canthus of the right eye. The densest pigmented portion was on the palpebral margin and particularly on the conjunctival side of the lower lid, extending from the outer canthus along the lower lid for about one third of its length. A smaller but less extensive lesion was present in the upper lid along the margin of the palpebral conjunctiva, near the external canthus. The pigmentation of the skin extended for 15 mm. temporally from the external canthus and into the upper and lower lid adjacent to it. There was no elevation of any of the lesion. At a consultation with Dr. James Ewing, it was decided that the lesion was precancerous. The patient insisted on trying irradiation, so this was given by Dr.

Martin to the right eye with radon in a glass bulb in the following doses (millicurie minutes with no filter in contact with the lesion):

Date	Mc. Min.
1/27/34	350 to lower lid
3/31/34	250 to outer canthus
6/23/34	250 to margin of lower lid
7/14/34	440 to skin lateral to external canthus
10/ 6/34	350 to skin at external canthus

The lesion regressed rapidly, so that at time this report is written, three years after treatment, no pigmentation is noted either in the skin or in the palpebral conjunctiva. There remains only the sequela that is expected after such irradiation, namely, the absence of cilia along the lower lid for about one third of its distance from the external canthus, and over the same area some atrophy and telangiectasis.

Summary.—There was a precancerous melanosis of the skin of the lids and adjacent palpebral conjunctiva. This was treated with irradiation before malignant signs appeared, and complete clinical regression ensued. There was no reappearance of the lesion after three years. No tissue was obtained for microscopic examination.

CASE 7.—W. E. B., a man, at the age of 43 first noticed a dark pigmentation of the conjunctiva of the left lower lid, mostly in the region of the fornix. He observed no change for five years, when the lesion began to increase in size rather rapidly. He consulted Dr. Grady Clay, of Atlanta, Ga., who found that the lesion involved the conjunctiva of the lower lid from the skin to the fornix and the contiguous bulbar conjunctiva up to the limbus. The inner canthus, including the caruncle and semilunar fold, was also affected. There was no localized tumefaction but merely a diffuse nonelevated pigmentation. No regional lymph nodes were palpable. The patient was sent to Dr. James Ewing and Dr. James Duffy, of New York, for consultation. They advised irradiation with a radon bulb. This was given by Dr. Duffy to the left eye in a glass bulb in the following doses (millicurie minutes with no filter in contact with the lesion):

Date	Mc. Min.
7/10/33	180 to left lower lid
8/14/33	240 to inner canthus
1/ 8/34	120 to upper lid
4/ 2/34	106 to lower lid, external
4/ 2/34	150 to lower lid, sulcus, two areas
4/ 2/34	80 to upper lid, mesially
12/18/34	125 to lower lid, mesially
12/18/34	125 to lower lid, laterally
6/12/35	175 to sclera, outer
6/12/35	312 to lower lid, two areas
6/12/35	312 to end of tarsal cartilage, two areas
12/ 2/36	240 to bulbar conjunctiva
12/ 2/36	180 to upper lid

The first irradiation was given on July 10, 1933. The following months the pigment in the melanotic areas became less, and at sites where formerly this

pigmentation was solid black it became mottled. The extent of the lesion also seemed to lessen. The area around the inner canthus showed no change. Further irradiation was given on August 14. For five months longer it was thought that regression was taking place. Three months later, however, the lesion had spread to the bulbar conjunctiva above and even to the upper palpebral conjunctiva. Further irradiation was given on April 2, 1934, and during the following eleven months regression was noted in some areas and progression in others, so that at the end of the period Dr. Clay reported a definite increase in the size of the lesion of the bulbar conjunctiva, especially at the limbus temporally where there was some invasion of the cornea. Also, he noted a considerable increase along the superior fornix. In three months more, in June 1935, a preauricular node was noted and removed by Dr. Grove, of Atlanta, Ga. A section of this was sent to Dr. Ewing, who reported it to be a malignant melanoma. Nine months later Dr. Clay reported a further progression of the lesion and particularly the presence of a small tumor mass in the fornix below. Nine months later a small mass appeared in the left side of the neck, the liver was palpable and the patient was losing weight. Two months later the patient died. A summary of the autopsy report, furnished by Dr. James J. Clark, of Atlanta, Ga., follows: "The liver weighed 10,500 Gm. and was quite nodular, and many of the nodules had necrosed. Fungating areas of cancer tissue were present outside of the capsule of the liver. The abdomen was distended with about 2,000 cc. of bloody fluid. Several nodules of tumor tissue were present in the mesentery, and each kidney contained tumor tissue which had erupted through the capsule. There were many enlarged mesenteric and retroperitoneal glands. The lungs, mediastinum and glands of the hilus were free from metastasis. Both eyes were obtained for examination and were normal except for the malignant melanoma of the conjunctiva."

Summary.—There was a precancerous melanosis of the palpebral and bulbar conjunctivae for five years prior to the development of diffuse malignant melanoma. Irradiation was used, with some regression, but metastasis and death ensued six years after the onset of malignant changes.

CASE 8.—N. D., a man, at the age of 48 first noticed a dark discoloration along the inner side of the right lower lid and over the white of the eye nasally. This discoloration resembled that caused by the use of mild protein silver, and attention was called to it by several of his friends. He felt that the lesion remained unchanged for the next three years, when it began to increase in size, and a small lump appeared near the edge of the lid. This prompted him to consult his local physician who removed the lump and gave a single application of radium, lasting six hours, the factors of which are unknown. During the next two years the lesion spread, so that when the patient was seen at the Memorial Hospital (fig. 1 E) it was represented by a dense, diffuse, mottled, brownish black, nonelevated pigmentation of the entire palpebral conjunctiva of the lower lid, its margin and the contiguous skin for a short distance. Also, the entire bulbar conjunctiva, except temporally and up, was similarly affected. The palpebral conjunctiva of the upper lid was also involved over the nasal and temporal portions. There was a small bluish black nodule in the lower lid which was about the size of the average chalazion. Regional glands were not palpable. There was marked conjunctivitis present, with considerable purulent discharge. On Oct. 10, 1937, the right orbit was exenterated, and a Thiersch graft from the thigh was inserted.

Summary.—There was a precancerous melanosis of the palpebral and bulbar conjunctivae for three years, after which the malignant growth developed, which in two years involved practically the entire palpebral and bulbar conjunctivae with a diffuse malignant melanoma. The lesion was flat, with no elevation except at one site in the lower lid, where a small nodule developed.

COMMENT

From these eight cases it can be said that the average age at which precancerous melanosis of the conjunctiva² is recognized is about 48 years, and the average time which elapses before malignant changes ensue is about five years.

DIFFUSENESS

An important characteristic of the type of malignant melanoma discussed in this paper is its diffuseness. The precancerous changes may extend over a wide area, involving sometimes almost all of the conjunctiva. Malignant areas may make their appearance at any site, and usually at many sites, either simultaneously or at varying intervals in the course of the disease. The malignant areas may remain flat, as in the precancerous stage, or they may be somewhat elevated (from 1 to 3 mm.). If the tumor is allowed to grow unheeded, it may ultimately grow into a localized tumor mass. Often, though, it remains flat or slightly elevated and may involve the entire bulbar and palpebral conjunctivae and terminate fatally by metastasis without even forming an elevated mass. Extensive involvement of the conjunctiva results, not necessarily by spreading by direct continuity from one malignant site but rather from multiple scattered foci of origin which arise at different sites in the diffuse precancerous melanosis.

RELATION TO NEVUS

A nevus of the conjunctiva is not an obligatory precancerous lesion, whereas acquired melanosis ultimately becomes malignant. In my experience many more malignant melanomas of the conjunctiva arise from an acquired melanosis or spontaneously than from a nevus. Those that seem to arise spontaneously may be preceded by an unobserved melanosis. In contrast to the diffuse flat character of the lesion described in this paper, the malignant melanoma arising from a nevus grows more as a localized tumor mass. The melanoma that is said to arise from an acquired nevus rather than from the usual congenital nevus seems, at least in some cases, to belong to the group described here, as acquired

2. Congenital melanosis of the conjunctiva, as seen in highly pigmented races and in melanosis oculi, is not to be confused with acquired precancerous melanosis.

melanosis has been incorrectly termed an acquired nevus. Also, many congenital nevi of the conjunctiva have no pigment, either clinically or microscopically, and may be unobserved. If such lesions take on pigmentation later in life, they may become apparent and therefore be considered acquired.

On the basis of the material afforded by these cases, the histologic changes in precancerous melanosis and diffuse malignant melanoma of the conjunctiva are as follows:

The earliest changes in precancerous melanosis appear in the basal layer. These cells increase in number, become pigmented and are separated from one another by clear spaces, and the individual cells swell or become hydropic (fig. 2 *a*). The swelling gives a large protoplasmic element to the cells, which may be perfectly clear or may show an amorphous granular content, which is often interspersed with varying numbers of pigment granules. Some cells show an enormous globular distention associated with degeneration of the nucleus, as evidenced by its poorly staining granular appearance. Several or many adjacent swollen cells may become confluent, forming clear spaces containing the degenerative products of the involved cells. The protoplasm of the less swollen cells may be finely granular or honeycombed and contain what seem to be small droplets, which simulate those seen in embryonic fat cells or foam cells. The nuclei are usually larger than those of the normal basal cell, and the chromatin may be more rarefied, often with a rather large nucleolus.

These altered basal cells proliferate in some places to only two or more cells thick, while in other places they segregate into clumps or nests (segregation), which invade the submucosa (fig. 2 *b*) and may lose their connection with the basal layer (*Abtropfungsprozess*). These nests may also invade the overlying mucosa (intra-epithelial growth), where they stand out in sharp contrast to the normal mucosal cells because of their clear hydropic protoplasm and a clear cleft or space around the nest (fig. 2 *c*). Individual heavily pigmented cells or lightly pigmented cells with clear protoplasm may be seen in the superficial layers of the mucosa and sharply demarcated from their surroundings. At some sites the altered basal cells invade and entirely replace the overlying mucosa. Small epithelial whorls, with slight cyst formation, may be seen occasionally beneath the mucosa. In the submucosa there are varying numbers of chromatophores representing the phagocytosed pigment which has migrated from the basal cells. In places there is sometimes noted a considerable number of chromatophores beneath a relatively normal appearing nonpigmented mucosa or beneath a thin atrophic mucosa or at a site with little or no mucosa on the surface. These areas apparently represent a regression of the lesion, with the resulting dis-

appearance of the mucosa, which in places has not regenerated or has regenerated with normal or atrophic epithelium, leaving only the phagocytosed pigment in the submucosa as remains of the active process. There is frequently a chronic inflammatory reaction of plasma cells and other types of lymphocytes, principally at the limit of the extension into the submucosa (fig. 2 *d*). An important characteristic of the lesion is its diffuseness. The basal layer over wide areas can show the characteristic precancerous changes which here and there become more

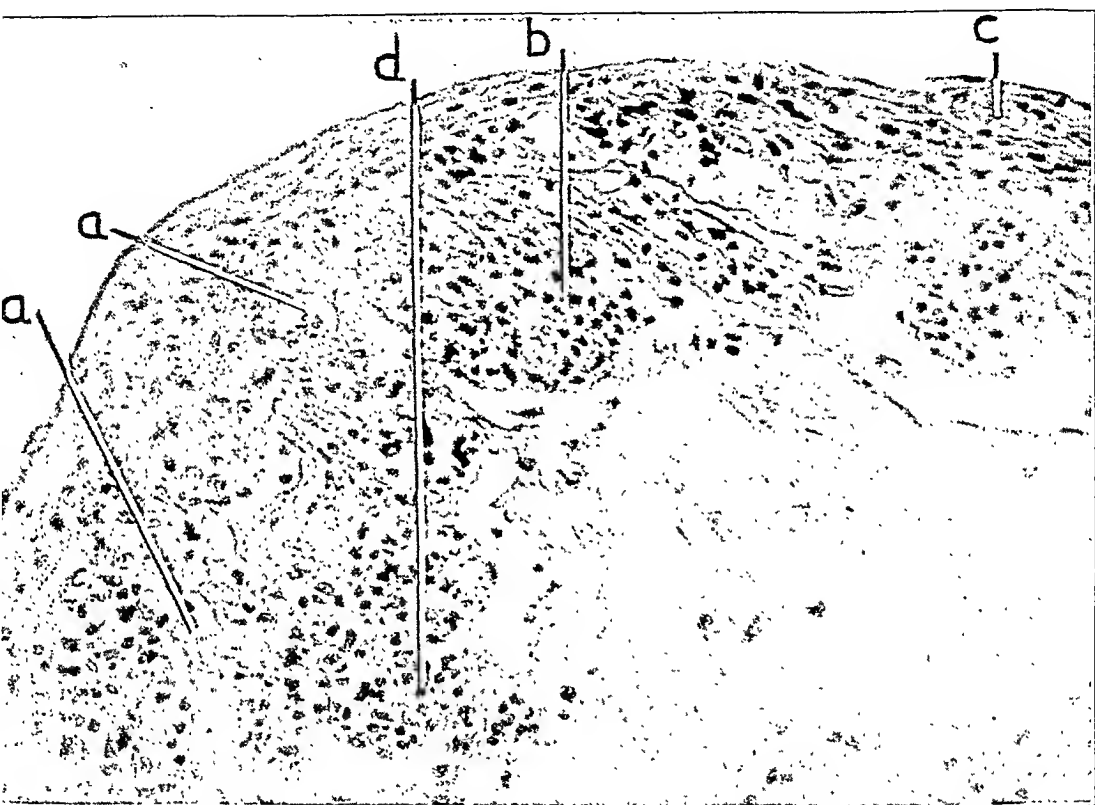


Fig. 2 (case 5).—Photomicrograph of tissue removed for biopsy just prior to exenteration: *a*, the swelling and hydrops of the proliferated basal cells; *b*, the segregation and *Abtrophungsprozess*; *c*, intra-epithelial growth, and *d*, a mild infiltration of lymphocytes.

advanced and show an increase in the pigmentation, segregation, *Abtrophungsprozess*, intra-epithelial growth, etc. As the lesion becomes malignant, it may still remain diffuse with little localized thickenings, elevation or tumor formation, or there may be tumor formation which is more marked at one or several sites. In a nevus one also sees some of the same characteristics of growth as was noted in these cases, such as segregation, *Abtrophungsprozess* and intra-epithelial extension. There were, however, no neuroid bodies seen or any other evidence to support

a neurogenic origin. I am of the opinion that there is every reason to believe that these tumors arise primarily from the potentially pigment-bearing basal layer of the conjunctiva.

In reviewing the literature on malignant melanoma of the conjunctiva it was often difficult to determine which tumors belonged to the group discussed in this paper, because some of the reports merely described the clinical appearance briefly and frequently gave no data concerning the course, follow-up study or histologic changes. Frequently, it could not be determined whether the lesion had become malignant or, if so, whether it arose originally from a nevus, a precancerous melanosis or spontaneously.

The cases of malignant melanoma of the conjunctiva in which the growth seemed to have developed at the site of an acquired melanosis are those reported by Fromaget,³ Fano,⁴ Dor,⁵ Capdeville,⁶ Blanch,⁷ Roper,⁸ Coppes, Capron,⁹ Silex¹⁰ and Löhlein.¹¹ Those in which the growth involved both the skin of the lids and the conjunctiva are reported by Hutchinson¹² and by Lafon and Teulières.¹³

SIGNS OF GROWTH

Besides an increase in size and pigment content, it is stated in the literature that in the cases in which the skin is involved the onset of malignant growth in an area of melanosis is frequently accompanied by signs and symptoms of inflammation. The patient in case 2, reported on here, was prompted to secure medical advice because the lesion had

3. Fromaget: *Mélanose conjonctivale et lentigo malin*, J. de méd. de Bordeaux 30:261, 1900.

4. Fano: *Mélanose et tumeur mélanique de la conjonctive*, Gaz. d. hôp. 45:651, 1872; *Recidive d'une tumeur mélanique de la conjonctive après une première extirpation*, *ibid.* 46:156, 1873.

5. Dor: *Pigmentation mélanique de la conjonctive*, *Mém. et compt.-rend. Soc. d. sc. méd. de Lyon* (1878) 18:61, 1879; *Une malade atteinte de pigmentation mélanique de la conjunctiva et d'une partie de la cornée*, *Lyon méd.* 28:101, 1878.

6. Capdeville, P. J.: *Contribution à l'étude de la mélanose conjonctivale*, Thèse de Bordeaux, no. 111, 1911, p. 50.

7. Blanch, A.: *Mélano-sarcome de la paupière*, *Rec. d'opht.* 4:620, 1882.

8. Roper, A. C.: *Melanotic Sarcoma of Conjunctiva with Pigmented and Non-Sarcomatous Growths in Skin*, *Tr. Ophth. Soc. U. Kingdom* 32:117, 1911-1912.

9. Capron, F. P.: *Multiple Melanotic Nevi of the Conjunctiva, with Malignant Invasion of the Corneal Limbus*, *Tr. Am. Ophth. Soc.* 14:322, 1915.

10. Silex, P.: *Ueber epibulbäre melanotische Sarcome*, *Arch. f. Augenh.* 20:59, 1889.

11. Löhlein, W.: *Ueber Melanosis der Bindehaut*, *Klin. Monatsbl. f. Augenh.* 68:389, 1922.

12. Hutchinson, J.: *On Tissue-Dotage*, *Arch. Surg., London* 3:315, 1891.

13. Lafon, C., and Teulières, T.: *Tumeur mélanique primitive de la paupière*, *J. de méd. de Bordeaux* 38:536, 1908.

occasioned some pain and was inflamed. In case 8 there was marked inflammation of the conjunctiva with a great deal of mucopurulent discharge. Microscopically, an inflammatory reaction of some degree was noted in most of the cases. Other signs indicating the onset of the malignant growth in cases in which the skin was involved were ulceration and hemorrhage. These occurred in some of the cases in which the conjunctiva was involved, but quite late in the course of the disease.

TRAUMA

In the literature a history of trauma is frequently mentioned, both in the cases in which the skin was involved and in those in which the conjunctiva was involved. The question as to whether the trauma called the patient's attention to a preexisting lesion or whether it was a precipitating factor must be considered. A history of trauma was obtained in only one case reported here. In case 3 the patient said he was hit in the involved eye with a roman candle several years prior to the development of the pigment spot.

SPONTANEOUS REGRESSION

Similar lesions that involve the skin are said sometimes to show areas of regression along with areas of progression. There have occurred authentic cases in which regression has continued to the point of complete disappearance of the lesion. I have never observed this clinically in cases in which the conjunctiva was involved, but I judge, on the basis of the microscopic appearance, that such processes of progression and regression sometimes go hand in hand. Clinically, therefore, this could give a changing picture from time to time. The increase and decrease of pigment in the lesion, as seen clinically, would not necessarily be an accurate criterion. When an area regresses, the conjunctiva disappears; later it may regenerate to an atrophic or relatively normal conjunctiva. The pigment, though, that was produced when the site was active, migrates to the submucosa and remains there in the chromatophores. Therefore, such pigment continues to be seen through the translucent, regenerated and maybe atrophic conjunctiva. Such is probably not the case with the opaque skin.

The patient in case 6 stated that he thought the pigmentation of the skin of the lids had shown some regression prior to treatment. The regression in some of the cases, accredited to irradiation, may have been in part or totally spontaneous.

TREATMENT

Because of the extensive involvement of the conjunctiva, even over areas not appreciable clinically, enucleation is not indicated, as usually

all of the conjunctiva should be removed. Therefore exenteration is necessary, and at the time this is done a Thiersch graft can be placed in the orbit on a gauze tampon. This graft takes well, even on the bare bony surface, and a long course of dressings during the period of granulation is thus avoided. Because of the rather unimportant clinical appearance of the lesion in the early stage, temporizing measures are often employed, and because its diffuseness is not sometimes appreciated, repeated local excisions are done. Much valuable time is thus frequently lost by not doing an early exenteration. Case 5 (fig. 2) was the only one in which exenteration was done early.

In the precancerous stage irradiation may be effective. This is based on the result in one case (case 6) in which the condition seems arrested after three years.

Drs. John M. Wheeler, Hayes E. Martin, James Duffy, Grady Clay and Franklin Bracken furnished me with data relative to patients who were under their care.

The drawings were made by Mr. Gustav Bethke and Miss Emily Freret; the technical work and the preparation of the photomicrograph, by Mr. N. E. Ross and Miss Lily Kneiske.

VITAMINS IN TREATMENT AND PREVENTION OF OCULAR DISEASES

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In this ever changing world the members of the medical profession have found it necessary to treat man's bodily and mental afflictions with newer and more specific therapeutic methods. This evolutionary change has been based on the advancement of science. In the past it was thought that many of the ailments of mankind were produced by changes in the humors of the body. With the advent of newer knowledge of bacteria and their associated toxins, a major portion of the diseases were attributed to bacterial invasion of the body; thus focal infection came into vogue as an underlying cause of many diseases. To this day effort is made to eliminate every possible source of infection in the treatment of inflammations of the various organs, particularly the eye, through eradication of foci of infection, such as the tonsils and teeth, opening of the sinuses and extirpation of many of the other diseased tissues. It has been demonstrated that the local disturbance thus treated is frequently aggravated.

It is obvious, therefore, that supplementary therapeutic measures must be considered in the treatment of some of these refractory diseases. From the experimental work of physiologists and others interested in the subject of nutrition, the members of the medical profession soon learned that the proper selection of food is a most important means of improving and maintaining health. In the light of this knowledge, it seemed advisable to recommend that these stubborn maladies be treated with a well balanced diet supplemented with necessary vitamins.

It has been shown by laboratory research that a specially planned faulty diet may produce definite pathologic changes in the animal body. This type of investigation cannot be duplicated in the clinic for many reasons. Nevertheless, similar dietary deficiencies have been observed among civilians in economic stress, particularly in other countries. It is from their unfortunate experiences and from the few reported cases in this country that it was learned that the incidence of these diseases varies with the climate and the economic status, food supply, age, sex,

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and occupation of the inhabitants. Although typical cases of dietary deficiency are few in the United States, it is now fully appreciated that milder forms of this condition are more prevalent than reported. The incidence of mild avitaminosis as a complication of other disease is estimated as very high. These mild deficiencies may occur not only as independent disturbances but frequently are complications of other diseases. It has been suggested that several mild deficiencies may be present in one person. It is essential to bear in mind that when the intake of food is restricted or when there is an interference with its absorption and utilization a vitamin deficiency may result.

When Osborne and Mendel¹ and McCollum and Davis² in 1913 reported ocular inflammations in their respective colonies of animals on a diet free from vitamin A, they opened a new era of nutritional investigation. It remained for McCollum and Simmonds³ to correlate these observations on rats with those reported by Bloch⁴ and Mori⁵ in children, and they came to the conclusion that the ocular disease produced experimentally in animals is the analogue of the corneal lesions which these authors reported in man. In view of this finding, they concluded that this type of ocular inflammation is a deficiency disease in the same sense as beriberi and is due specifically to the lack of vitamin A. The work of these pioneers led many investigators, laboratory and clinical, to reinvestigate and to interpret the vast number of previously known ocular disturbances which were reported in the literature. It became apparent that many of these diseases, particularly xerophthalmia and keratomalacia, were in part, at least, produced because of improper food or the lack of a specific vitamin.

It was evident to some observers that xerophthalmia and keratomalacia were late manifestations of vitamin A deficiency, and in 1924 Holm⁶ showed that hemeralopia developed early in rats which were kept on a diet free from vitamin A. He also noted that hemeralopia did not result from vitamin A deficiency alone but that it was necessary

1. Osborne, T. B., and Mendel, L. B.: The Influence of Butter Fat on Growth, *J. Biol. Chem.* **16**:423, 1913.

2. McCollum, E. V., and Davis, M.: The Essential Factors in the Diet During Growth, *J. Biol. Chem.* **23**:231, 1915.

3. McCollum, E. V., and Simmonds, N.: The Minimum Requirements of the Two Unidentified Dietary Factors for Maintenance as Contrasted with Growth, *J. Biol. Chem.* **32**:181, 1917.

4. Bloch, G. E.: Eye Diseases and Other Disturbances in Infants from Deficiency in Fat in the Food, *Ugesk. f. læger* **79**:349, 1917; abstr., *J. A. M. A.* **68**:1516 (May 19) 1917.

5. Mori, M.: Ueber der sogenannten Hikan (Xerosis conjunctivae infantum ev. keratomalacie), *Jahrb. f. Kinderh.* **59**:175, 1904.

6. Holm, E.: Demonstration of Hemeralopia in Rats Nourished on Food Devoid of Fat-Soluble-A Vitamin, *Am. J. Physiol.* **73**:79, 1925.

to expose the animals to light before it became manifest. The hemeralopia was cured within two or three days by giving the animals an ordinary diet. Sugita⁷ likewise demonstrated hemeralopia in rats with vitamin A deficiency. In 1923, however, Fridericia and Holm⁸ reported that regeneration of the visual purple after bleaching by light was considerably slower in rats on a diet free from vitamin A than in rats on a normal diet. This observation was also confirmed by Tansley,⁹ who followed the course of regeneration of the visual purple in normal rats and in rats deficient in vitamin A. She noted that if the animals were well depleted of vitamin A it took longer for the visual purple to regenerate. In this manner it was shown that the visual purple and hemeralopia were intimately associated in experimental vitamin A deficiency. Later Holm¹⁰ observed a considerable vitamin A content in the retina, and this was confirmed by similar feeding experiments in 1931 by Kriss, Smith and myself.¹¹ With the aid of the spectroscope, Wald¹² found vitamin A in considerable concentration in solutions of visual purple extracted from the retina and the pigmented choroidal layer of the frog, pig and cattle.

In view of these experiments on animals which showed that hemeralopia was the first demonstrable ocular symptom of vitamin A deficiency, that the content of the visual purple in the retina was disturbed and that considerable vitamin A was present in the normal retina of the experimental animal, the question arose as to whether vitamin A deficiency in man might not also manifest itself, in addition to other symptoms, by varying degrees of hemeralopia, depending on the degree of avitaminosis.

An extensive investigation of hemeralopia was recently made by Frandsen,¹³ and the report is very interesting because of her detailed

7. Sugita, Y.: Experimentelle Untersuchungen ueber die Wirkung der Galle und ihrer Bestandteile auf das Auge, speziell auf den Lichtsinn und den Sehpurpur, nebst Bemerkungen über meine Sehpurpur-Lösungsmethode, *Arch. f. Ophth.* **116**: 653, 1925.

8. Fridericia, L. S., and Holm, E.: Experimental Contribution to the Study of the Relation Between Night Blindness and Malnutrition: Influence of Deficiency of Fat-Soluble-A Vitamin in the Diet on the Visual Purple in the Eyes of Rats, *Am. J. Physiol.* **73**:63, 1925.

9. Tansley, K.: Factors Affecting the Development and Regeneration of Visual Purple in the Mammalian Retina, *Proc. Roy. Soc., London, s.B* **114**:79, 1933.

10. Holm, E.: Demonstration of Vitamin A in Retinal Tissue and a Comparison with Vitamin Content of Brain Tissue, *Acta ophth.* **7**:146, 1929.

11. Yudkin, A. M.; Kriss, Max, and Smith, A. H.: Vitamin A Potency of Retinal Tissue, *Am. J. Physiol.* **97**:611, 1931.

12. Wald, G.: Vitamin A in the Retina, *Nature, London* **132**:316, 1933; Carotenoids and the Vitamin A Cycle in Vision, *ibid.* **134**:65, 1934.

13. Frandsen, H.: Hemeralopia as an Early Criterion of A-Avitaminosis and Clinical Symptoms and Treatment of This Disease, *Acta ophth., supp.* 4, 1935, p. 1.

study of the subject. She divided the causes of hemeralopia into two groups, namely, conditions giving rise to changes in the light-refractive apparatus and those giving rise to changes in the light-perceptive apparatus. If the cornea, anterior chamber, lens or vitreous chamber is involved, the light-refractive apparatus is injured; if the retina and choroid are involved, the light-perceptive apparatus is injured. In the latter group Frandsen included a number of different conditions that affect the retina, such as congenital total color blindness and "congenital family hereditary hemeralopia," and malaria, gastro-intestinal disturbances, nephritis, diabetes, anemia, cachexia and hepatic disturbances. Frandsen also pointed out that hemeralopia may be associated with poisoning caused by quinine, carbon disulfide, alcohol, nicotine, epinephrine and various poisonous gases employed in warfare, besides the diseases of the retina and choroid, such as syphilitic choroiditis, disseminated choroiditis, retinitis pigmentosa, detachment of the retina, optic atrophy, optic neuritis, sympathetic ophthalmia, glaucoma and excessive myopia, and Oguchi's disease.

It is not unusual, according to Frandsen, to find a mild degree of hemeralopia during a cursory examination for glasses. The symptoms are so relatively mild that the patient does not seek medical aid. On the other hand, the same symptoms have been severe enough to inconvenience the patient a great deal. Frandsen expressed the belief that there is a considerable difference in the intensity of the symptoms which accompany hemeralopia in men and in women; the symptoms are most pronounced in women at puberty and during the menopause. With a special apparatus she found great individual differences in the hemeralopia of normal school children and of normal adults; also, a number of persons kept on an institutional diet deficient in vitamin A demonstrated hemeralopia of various degree, and patients in private ophthalmologic practice showed hemeralopia much more frequently than other healthy persons.

I am much impressed with Frandsen's views concerning the similarity of the ocular symptoms observed in persons with mild hemeralopia and in those presenting clinical pictures of neurasthenia and hysteria. The symptoms attributed to the latter are asthenopia, poor visual acuity without a definite error of refraction, photophobia, "glare blindness," muscae volitantes, after-images and reduction in the field of vision, which is greater when the patient becomes tired. According to Frandsen, these symptoms may also be present in patients presenting essential hemeralopia.

It may be possible that the same fundamental disturbance of the retina is present in all of these conditions. It is not necessarily a vitamin deficiency. The ocular phenomena in cases of hysteria may be produced

by a disturbance of the perceptive organs of the retina by stimulation with light. It is a known fact that ocular stress in cases of neurasthenia and hysteria is frequently alleviated by the use of plain or tinted lenses and the assurance of relief. I have found the same type of symptoms in patients who cannot be considered as hysteric or neurasthenic or as deficient in the dietary essentials. Most of these persons have blond fundi, and the skin of their body burns when exposed excessively to the sun. Such a person cannot tolerate the rays of the sun or artificial light, has difficulty in driving at night because of the glare of lights but does not experience night blindness. A corrective lens does not always relieve the ocular symptoms. When the patient is given a well balanced diet and rests the eyes when mentally or physically fatigued, the ocular distress disappears and the general health improves.

In view of the similar observations in persons with neurasthenia or hysteria, in those who show definite hemeralopia and in those who have a blonde "make-up," it seems that a method should be found to demonstrate the underlying cause of this ocular disturbance. It is important to decide whether hemeralopia and poor dark adaptation are synonymous, for at present investigators are classifying poor dark adaptation as hemeralopia, and some have gone still further and assumed that poor dark adaptation or hemeralopia is a sign of vitamin A deficiency. I cannot fully subscribe to the latter assumption until further investigation is made. Some of the pharmaceutic brochures are even attributing "glare blindness" to a vitamin A deficiency.

Many types of apparatus and different methods have been used for demonstrating hemeralopia, dark adaptation and "glare blindness;" therefore, it is difficult to compare the various results. At present possibly two instruments may be used in measuring dark adaptation, one devised by Feldman¹⁴ and one devised by Hecht and his associates.¹⁵ Slight degrees of this condition are difficult to diagnose. There are individual variations of dark adaptation, even in healthy persons who have no ocular symptoms. It is apparent that if methods of examination for dark adaptation are to be serviceable in vitamin research they must be easy to manipulate, must not be cumbersome and should be scientific enough for accurate and constant readings. Then clinical observations must be made and norms established. It is important that a decision be made whether poor dark adaptation is the same as hemeralopia and whether the latter is a reliable criterion of vitamin A deficiency. What role do "glare blindness" and retinal fatigue play in this syndrome?

14. Feldman, J. B.: An Instrument for Qualitative Study of Dark Adaptation, *Arch. Ophth.* **18**:821 (Nov.) 1937.

15. Hecht, S.; Haig, C., and Wald, G.: The Dark Adaptation of Retinal Fields of Different Size and Location, *J. Gen. Physiol.* **19**:321, 1935.

RESULTS OF VITAMIN THERAPY

I shall leave this academic discussion and review the results obtained in ocular diseases in which vitamin therapy was employed. At the University Clinic (Yale) many patients with types of ocular disturbances have been treated with vitamins. Many persons with phlyctenular keratoconjunctivitis who were given a well balanced diet, cod liver oil and a standard brand of brewers' yeast became well within one week. These persons did not receive ocular therapy. A number of patients with interstitial keratitis improved rapidly when vitamin therapy was given simultaneously with the local treatment. In one instance the ocular condition improved before the specific therapy was instituted. Frequently there was encountered in children and infants a dryness of the cornea, with similar changes in the epithelium of the conjunctiva, which improved when a diet high in vitamin A was given. Children occasionally appeared in the clinic with a broken-down cornea that was not accompanied by a noticeable ciliary injection. When they were treated systemically (a diet high in vitamin content), the corneal lesion disappeared. Recently my co-workers and I¹⁶ described a similar condition encountered in adults. The patients' ages ranged from 45 to 68 years. A thorough physical examination did not reveal any signs or manifestations of infection; the histories of the patients indicated that the condition was accompanied by loss of appetite, constipation, headache and general malaise. Invariably these patients had lost their teeth early in adult life. The first complaint was that of having something in the eye and photophobia. The cornea appeared normal at first; nevertheless, the eye was extremely painful. The patients noted no visible ocular disturbance. When the eye was examined, there was a breaking down of the periphery of the portion of the cornea which was exposed in the palpebral fissure or in the area covered by the lower lid. There was little if any congestion present. The cornea often stained with fluorescein. The lesion did not seem to improve with local treatment, and within a few days the ulcer appeared to be more extensive. The invaded cornea presented a shallow excavated ulceration, which frequently spread along the margin of the cornea and extended toward the pupillary area. Examination of this area with the slit lamp revealed a swollen, edematous corneal epithelium and a similar involvement of the substantia propria. The surrounding tissue showed considerable vascularity. The corneal nerve fibers extending into the diseased area were prominent.

In this type of corneal lesion, particularly in the early stages, no definite inflammation of the deeper layers of the cornea and uveal tract

16. Yudkin, A. M.; Orten, A. U., and Smith, A. H.: The Production and Cure of Ocular Disturbances in Adult Albino Rats by Adjustment of Vitamin A, *Am. J. Ophth.* **20**:1115, 1937.

can be detected. Often the lesion is described as a catarrhal ulcer, without any definite inflammation of the conjunctiva. In some instances the ulceration has the appearance of a lesion of the cornea produced by an injury, but no history of injury can be elicited. Frequently, when first seen, the corneal lesion resembles a marginal ulcer, indolent ulcer or rodent ulcer. At this stage the aqueous humor reveals numerous floaters, and Descemet's membrane is sometimes studded with deposits, showing the uvea involved at this stage.

The treatment of this type of corneal lesion has been unsatisfactory. Local medication and heat seem to aggravate and delay the healing process, producing a refractory condition. It is frequently necessary to cauterize the cornea with full strength tincture of iodine or phenol. In this stage the cornea often becomes infected and a hypopyon results, necessitating more drastic treatment.

It was suggested from experience in the laboratory with animals with deficiency diseases that this condition might be a nutritional disturbance; therefore, a number of these patients at the clinic were given cod liver oil in addition to their regular diet. Some showed improvement in a short time, whereas others did not respond. It was evident that some other factor was involved. From the histories of the patients it appeared that the intestinal tract might be at fault. Large quantities of vitamin B complex were given before each meal in addition to the cod liver oil. In the majority of instances the systemic and ocular disturbances disappeared.

Although hemeralopia is the outstanding symptom in retinitis pigmentosa, no definite improvement has been noted when a diet high in vitamin content is employed. I am satisfied that the visual acuity and field of vision in late stages of retinitis pigmentosa are not improved by constant oral administration of potent cod liver oil, its concentrates or the precursor of vitamin A, beta carotene. At the clinic vitamin B complex in large quantities was added to the vitamin A, but the results were the same. The patients were of the opinion that they saw better during the day and found their way about better at night, yet the visual acuity and visual fields, as a rule, showed no improvement on ocular examination. When the neuro-epithelium is destroyed it is difficult to regenerate it. I recommend, however, that this type of therapy be continued, for it is the best there is to offer these unfortunate persons. It is my impression that retinitis pigmentosa if treated early with a diet high in vitamin content may be held in abeyance.

It is remarkable how quickly chorioretinal disturbances alleged to have a focal infection as their underlying cause clear up when the patient is given a well balanced diet enhanced by vitamin A and brewers' yeast powder. It is the policy at the clinic to treat the general condition of the patient simultaneously with the ocular condition. Focal infections

are usually removed, but not until the patient's general health is improved. I have seen too many unfavorable results from disturbing focal infections when the patient's resistance is not too good. Although it has been possible in many instances to cure, check and improve corneal lesions and retinal disturbances by supplementing the diet with vitamin A and B complex, I do not believe that a chorioretinal disturbance should be considered a true vitamin A or B complex deficiency.

VITAMIN B COMPLEX

To one who has been privileged to study many generations of rats in the laboratory and to watch their response to minute changes in the diet, particularly that of the vitamins, there can be little doubt about the necessity of these substances for the maintenance of health and normal growth. Vitamin B complex plays an important role in this respect. At present it is postulated that at least seven factors necessary for animal existence are found in B complex. There are too many controversies as to the effects and needs of all these separate factors. Vitamin B₁, known as the antinueritic vitamin, and vitamin B₂, or G, have been isolated and are available in pure form.

VITAMIN B₁

It has been definitely shown that vitamin B₁, or B, is of value in correcting and preventing anorexia of dietary origin, in securing optimal growth of infants and children, in curing and preventing beriberi and in treating some conditions in which difficulty is encountered in utilizing ordinary foods in the usual way, such as pernicious vomiting of pregnancy. It is claimed that vitamin B₁ has an influence on intestinal motility, and it appears to be in some way concerned in the metabolism of carbohydrates in the body. There is definite evidence that several forms of neuritis in man have vitamin B₁ deficiency as the main etiologic factor or as an important contributory factor.

It has been shown that a sufficient amount of alcohol destroys the proteolytic activity of certain gastro-intestinal enzymes *in vitro* and *in vivo*. It is suggested that alcoholic polyneuritis or deficiency disease may be caused, in part at least, by faulty digestion and assimilation of food resulting from the destruction of digestive enzymes by large quantities of alcohol taken over a considerable period of time.

In 1933 I¹⁷ reported the cure of toxic amblyopia due to alcohol and tobacco in patients who were allowed to smoke and drink a moderate amount of alcohol when they were treated with a diet high in vitamins.

17. Yudkin, A. M.: Ocular Disturbances Produced in Experimental Animals by Dietary Changes: Clinical Implications, *J. A. M. A.* **101**:921 (Sept. 16) 1933.

Similar results have since been reported by Carroll,¹⁸ who placed his patients under supervision in a hospital and observed cures in those in whom the optic nerve was not atrophied.

There are many instances of the cure of toxic amblyopia on removal of the offending drugs and the improvement of the general nutrition, but at no time has the condition improved so rapidly as when high vitamin therapy was employed. It is apparent that toxic amblyopia may be associated with a deficiency disease, for in the light of what has been said it appears that alcohol taken over a long period destroys digestive enzymes and thus prevents the proper digestion and assimilation of food.

VITAMIN B₂

According to Sherman,¹⁹ vitamin B₂, or G, is essential to growth and to normal nutrition at all ages. When the food is poor in vitamin B₂ for any considerable length of time, digestive disturbances, nervous depression (different from the symmetrical polyneuritis of vitamin B₁ deficiency), general weakness and deterioration of tone and an unhealthy or unthrifty condition of the skin are likely to develop. The incidence of infectious disease seems likely to be increased, vitality diminished, life shortened and the prime of life curtailed by the early onset of senility. Evidence from several laboratories indicates that the heat-stable vitamin of the B complex, recognized as B₂, or G, consists of two factors: lactoflavin and B₆ (antidermatitic). B₂, or flavin (d-riboflavin), is important to the ophthalmologist, for in 1931 Day, Langston and O'Brien²⁰ described the consistent appearance of cataract in rats as a result of a deficiency of vitamin B₂, or G. This observation was corroborated by me¹⁷ and by others when the instruction of preparing the diet and feeding it was carried out according to the directions given by Day and others. Recently Day and his collaborators²¹ demonstrated that cataracts did not develop in rats on a diet deficient in vitamin B₂, or G, if from 60 to 90 micrograms of pure lactoflavin was added to the diet weekly. Lactoflavin is of particular interest because of the existence of a flavin enzyme—a dehydrogenase. This compound appears to be a combination of flavin and other radicals and is the first example of an enzyme having a vitamin as an integral part. Vitamin B₂ may also be

18. Carroll, F. D.: Analysis of Fifty-Five Cases of Tobacco-Alcohol Amblyopia, *Arch. Ophth.* **14**:421 (Sept.) 1935.

19. Sherman, H. C.: *Chemistry of Food and Nutrition*, New York, The Macmillan Company, 1937.

20. Day, Paul L.; Langston, W. C., and O'Brien, C. S.: Cataract and Other Ocular Changes in Vitamin G Deficiency, *Am. J. Ophth.* **14**:1005, 1931.

21. Day, Paul L.; Darby, W. J., and Langston, W. C.: The Identity of Flavin with the Cataract-Preventive Factor, *J. Nutrition* **13**:389, 1937.

present in the lens, for Fischer²² in 1934 extracted a water-soluble green-yellow fluorescent substance which he believed to be lactoflavin. It is possible that more information concerning its presence or absence in the lens will be forthcoming. It is obvious that vitamin B₂ must play some role in the development of the lens and in protection against cataract in the albino rat.

VITAMIN C

From the experimental work and the clinical observations made with the products of nature containing vitamin C, it became apparent that vitamin C not only gave protection from scurvy but had many other important functions. It is true that there are many other disturbances which a low intake of vitamin C produces. Outstanding among the pathologic conditions is a weakening of blood capillaries. The defect in the capillaries in vitamin C subnutrition was shown by Wolbach and Howe²³ (1926) to result from a failure of the endothelial cells to form the intercellular cement substance, and they suggested that this failure extends to the connective tissue in other parts of the body. Hemorrhage due to the abnormal capillary fragility plays an important part in sub-clinical vitamin C deficiency. Eddy and Dalldorf²⁴ reported that weakened capillaries (capillary fragility) could be demonstrated in from 35 to 66 per cent of the children received from the economically poorer homes into the Grassland Hospital, Westchester County, N. Y. Most of these children responded promptly to treatment with antiscorbutic foods, thus showing that the capillary fragility here observed was mainly due to the shortage of vitamin C in the previous diet. It was shown that intravenous administration of vitamin C decreases the coagulation time of the blood. Beneficial results of intravenous and oral administration of vitamin C in cases of hemorrhagic diathesis, hematuria, purpura and essential thrombopenia have been reported by several authors. As yet no correlation has been demonstrated between capillary resistance and the concentration of vitamin C in the blood plasma or the urinary excretion of the vitamin. The estimations of vitamin C in the urine and of capillary fragility are utilized for determining the status of the vitamin C content of the body. Unfortunately, there seem to be individual variations in the urinary excretion of vitamin C, so that the test is not accurate, and capillary fragility may be due to other conditions.

It has been my privilege to treat many patients with hemorrhagic retinitis of various types with cevitamic acid. The treatment seemed

22. Fischer, F. P.: Die reduzierenden Substanzen der Linse, *Arch. f. Augenh.* **108**:527, 1934; Die fluoreszierenden Substanzen der Linse, *ibid.* **108**:544, 1934.

23. Wolbach, S. B., and Howe, P. R.: Intercellular Substances in Experimental Scorbutus, *Arch. Path.* **1**:1 (Jan.) 1926.

24. Eddy, W. H., and Dalldorf, Gilbert: *The Avitaminosis*, Baltimore, Williams & Wilkins Company, 1937.

to shorten the time ordinarily required for the repair of this type of lesion. It was noted, however, that synthetic vitamin C does not have the same effect on retinal and vitreous hemorrhages as lemon juice. Lemon juice seems to clear the extravasation of blood and edema much more rapidly. I quite agree with Rusznyák and Szent-Györgyi²⁵ that there is something else in lemon juice that is effective in breaking down and aiding in the absorption of hemorrhages of the vitreous, choroid and retina. It is my policy to prescribe for this type of ocular disturbance the juice of at least four or five lemons daily. May I suggest that a more careful and painstaking investigation be made with lemon juice and vitamin C therapy in ocular conditions of this nature? May I warn the investigator, however, that vitamin C is frequently not absorbed readily and that the source of the vitamin is variable?

Vitamin C is also considered of fundamental importance in tissue respiration, acting as a "hydrogen transport agent" between organic metabolites and, indirectly, molecular oxygen. It is discovered that crystalline lens and aqueous humor have a high reducing value toward the dye 2,6-dichlorophenolindophenol. In order to prove that the reducing substance concerned was cevitamic acid, the antiscorbutic activity of lens and aqueous was tested biologically; that is, lens tissue and aqueous humor were fed to guinea pigs which had been kept on a diet free from vitamin C until loss of weight occurred and symptoms of scurvy appeared; the vitamin C content of the tissue was estimated by the dose required to produce recovery. It was observed that the antiscorbutic potency of lens and aqueous as tested by the biologic method was much less than that indicated by the chemical estimation. The investigators concluded that this lack of agreement between the biologic and the chemical methods of estimation was due not to a lack of vitamin C in the tissue but to the presence of a toxic substance. Nothing is known with certainty regarding the function of vitamin C in the metabolism of the lens. It has been suggested that cevitamic acid and glutathione may be two linked factors in one system of oxidation in animal cells. A number of investigators have recently shown that various enzyme systems are activated or inhibited by vitamin C, but nothing is known concerning its relation to enzyme systems in the lens. The center of the lens, which respire less than the outer layers, contains less vitamin C.

The relation of vitamin C to the formation of cataract is problematic. It appears highly probable that this substance has some essential function in the metabolism of the normal lens, and if this is so, any condition which would lead to its withdrawal might be expected to induce degenerative changes. However, cataract is not associated clinically with

25. Rusznyák, S., and Szent-Györgyi: Vitamin P: Flavonols as Vitamins. *Nature*, London **138**:27, 1936.

scurvy in human beings, nor is its occurrence recorded in experimental animals on scorbutic diets.

The observations recorded here are all fairly recent and many of them require confirmation. It is evident that more information as to the function of vitamin C in the normal lens is required before any theory as to its relation to the formation of cataract can be elaborated. Nevertheless, it has been my policy in recent years to give any adult patient showing early lenticular changes or tumescence associated with refractive changes the following therapeutic advice: Regulate the daily diet so that the proper amount of calories is obtained. Do not rely on any fanatic diet for sustenance. Before breakfast and dinner take the juice of at least one lemon, either as a lemonade or in some other non-alcoholic combination. Take a teaspoonful of potent brewers' yeast powder or some other equivalent vitamin B complex twice daily before meals. If there is a cardiovascular condition present, see that the system is compensating. The latter disturbance may require the aid of an internist. Up to the present time I am satisfied that when no permanent changes are present in the lens in the form of opacities it is possible to repair early damage in the lens by the aforementioned therapy.

To what extent vitamin D and E are factors in the maintenance of normal ocular function or in the repair of pathologic ocular conditions is impossible to say at present. Several ocular disturbances, particularly the formation of lenticular opacities, have been attributed to lack of vitamin D in the diet. It is my impression that when considerable vitamin D in the form of viosterol and other similar products is given to children and supplemented by exposure to the sun or to artificial sun rays, a distressing granular conjunctivitis is produced. Further investigation of these and other vitamins may change the present concept of their requirements in ophthalmology.

CONCLUSION

It is apparent from analyzing laboratory statistics and clinical observations that the vitamins play a definite role in the therapy of ocular diseases. Vitamin A seems to be useful in the treatment of corneal inflammations and chorioretinal disturbances. The normal function of the rods and cones of the retina are enhanced by the use of vitamin A. Vitamin B complex is useful in the treatment of toxic amblyopia, particularly that produced by the use of alcohol and tobacco. In patients in whom focal infection is thought to be the underlying cause of the ocular inflammation, a combination of vitamin A and B complex is helpful. Vitamin C has been used for extravasation of blood in the vitreous, choroid and retina, but I find that lemon juice is more beneficial. Lemon juice is helpful in ocular disturbances in which the lesion may be due to improper vascular compensation. At the present time I find no definite use in ophthalmology for vitamins D and E.

RESULTS OF STELLECTOMY IN THE TREATMENT OF PIGMENTARY RETINITIS

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In September 1933 I presented, in collaboration with Drs. Malbrán and Balza, before the Society of Ophthalmology of Buenos Aires¹ the results that we had obtained for the first five patients with pigmentary retinitis treated by stellectomy; later, in 1934, in another publication,² we reported on a total of twelve patients with pigmentary retinitis treated by this method (the first five being included) and summed up the effects of the operation.

The time that has gone by since the operation in these cases, the favorable change in many of these patients and the undoubted benefits following this operation in additional cases have encouraged us to dwell once again on the subject so as to draw the attention of specialists to the value of stellectomy in the treatment of pigmentary retinitis.

The indifference and doubts of ophthalmologists in regard to the practical value of operations on the sympathetic nervous system in pigmentary retinitis are due to unacquaintance with the etiology of the malady, its severity and the scarcity and inefficiency of the therapeutic resources available today. But facts in medicine are as powerful as laws.

It may be said that there is some quackery in suggesting sympathectomy for pigmentary retinitis, but it is evident that patients with this condition who have been operated on by this method have shown real improvement, and these results, whether based on quackery or on scientific principle, are eloquent.

In late years the circle interested in pigmentary retinitis has been agitated by works that have published the results of operations on the sympathetic nervous system for this disorder and reported cases in which unquestionable success was obtained with this procedure in spite of the irregularity of its effects.

1. Caeiro, J. A.; Malbrán, and Balza, J.: Tratamiento de la retinitis pigmentaria por la resección del simpático cervico-torácico, *Rev. Asoc. méd. argent.* **47**:3403, 1933.

2. Caeiro, J. A.; Malbrán, and Balza: Resultados obtenidos en el tratamiento quirurgico de la retinitis pigmentaria por la extirpación del ganglio estelar, *Prensa méd. argent.* **21**:2245 (Nov. 28) 1934.

In Buenos Aires my associates and I have operated on several patients for whom stellectomy has given good results, and we have been pleased to see some of our ideas reproduced in foreign works.

Until our report was published the results in a few cases of Meighan,³ Campbell⁴ and Royle⁵ gave glimpses of the possibilities of resection of the sympathetic chain.

In an emphatic manner we have praised stellectomy by "low resection," as the Americans call it, because we consider it the most complete and effective operation in regard to the anatomicophysiologic basis, and its results have not disappointed us.

Recently Drs. Villegas and Pasman operated on some patients with pigmentary retinitis (these cases have not been published), using stellectomy performed according to my technic, and they obtained in some of these cases results that are flattering.

In 1934 and 1935 important contributions on this subject were published by MacDonald and Mackenzie,⁶ Gifford and de Takáts,⁷ Walsh and Sloan,⁸ Kerr⁹ and Greene¹⁰ in North America.

Before the Academy of Surgery of Paris in 1936,¹¹ in reporting on work on surgical intervention on the sympathetic nervous system carried on with Fontaine, Leriche drew attention to the benefits obtained in a patient with pigmentary retinitis who was operated on by this method.

To sum up the results obtained, all these authors, in spite of the caution that every new treatment inspires, advise research in order to arrive at more definite conclusions and suggestions regarding this procedure in view of the favorable changes seen in some patients operated on by this method.

3. Meighan, S. S.: Treatment of Retinitis Pigmentosa by Sympathectomy, Tr. Ophth. Soc. U. Kingdom **51**:124, 1931.

4. Campbell, G.: Sympathectomy in a Case of Retinitis Pigmentosa, Canad. M. A. J. **26**:674 (June) 1932.

5. Royle, N. D.: Treatment of Blindness Associated with Retinitis Pigmentosa, M. J. Australia **2**:111 (July 23) 1932.

6. MacDonald, A. E., and Mackenzie, K. G.: Sympathectomy for Retinitis Pigmentosa, Arch. Ophth. **13**:362 (March) 1935.

7. Gifford, S. R., and de Takáts, Géza: Cervical Sympathectomy in Retinitis Pigmentosa: Preliminary Report on Results, Arch. Ophth. **14**:441 (Sept.) 1935.

8. Walsh, Frank B., and Sloan, Louise L.: Results of Cervical Sympathectomy in Pigmentary Degeneration of the Retina, Arch. Ophth. **14**:699 (Nov.) 1935.

9. Kerr, Harry: Surgical Treatment of Retinitis Pigmentosa, Am. J. Surg. **28**:364, 1935.

10. Greene, Louis: Personal communication to the authors, mentioned by Walsh and Sloan,⁸ p. 713.

11. Leriche, R., and Fontaine, R.: Résultats généraux de 1,256 sympathectomies, Mém. Acad. de chir. **62**:877 (June 10) 1936.

ETIOLOGIC BASIS FOR SURGICAL INTERVENTION ON THE
SYMPATHETIC SYSTEM

The etiology of pigmentary retinitis has not yet been determined exactly. For some time this disorder was considered to be due to a condition of the capillaries.

Subsequently Collins, although admitting the influence of the vascular alteration, stated that he considered this to be secondary, the original phase of the disease being atrophy of the neuro-epithelium.

The modern anatomicopathologic studies of Verhoeff¹² have confirmed Collins' ideas. Verhoeff considered the atrophy of the neuro-epithelium, particularly the layer of the rods, as a consequence of hepatic disturbance, the fundamental origin of the malady.

Vascular therapeutics were little by little abandoned, and treatment was directed in accordance with these new ideas, with the suggestion of hepatic opotherapy, the administration of insulin and vitamins and other treatment.

Nevertheless the results obtained with the reaction following sympathectomy and its influence in bringing about a better retinal circulation brought up again the vascular theory.

Suppression of the sympathetic innervation, by eliminating the constrictor action of the blood vessels, allows a greater affluence of blood through permanently paralytic vessels and expansion in all the vascular circuits of the eye (choroidal and retinal).

Some authors, such as Goltz and Freusberg,¹³ have affirmed that some time after sympathectomy, the capillary functions are restored to their former status. These ideas at present cannot be admitted when ganglionic sympathectomy is performed, for experience has proved that with this operation the phenomena of vascular expansion that are attained are persistent (Diez¹⁴) or, at least, last a long time.

When Royle and Meighan performed cervical sympathectomy for pigmentary retinitis their intention was to modify the ocular circulatory condition in order to obtain better nourishment of the retina.

I believe that the suppression of the sympathetic innervation creates new conditions of life in the tissues, producing modifications of their nourishment and trophic state. These phenomena, which can be seen in all the tissues of the organism, are more pronounced the greater the cellular difference is.

12. Verhoeff, F. H.: Microscopic Observations in a Case of Retinitis Pigmentosa, *Arch. Ophth.* 5:392 (March) 1931.

13. Goltz, F. R., and Freusberg, A.: Gefässerweiternde Nerven, *Arch. f. d. ges. Physiol.* 9:179, 1874.

14. Diez, J.: La tromboangéitis oblitterante, Buenos Aires, El Ateneo, 1934.

The retina, the cells of which are ultradifferent, owing to its nature and functions, is more sensitive to any trophic or nutritive change than other parts.

Ganglionic sympathectomy in modifying fundamentally the trophism of the neuro-epithelial cells creates new protoplasmatic activity, stimulating a better cellular metabolism. The permanent vascular expansion and the greater affluence of blood change substantially the nutritive conditions of the cells, which awaken to new activity.

ELECTION OF PLACE AND SIDE FOR RESECTION OF THE SYMPATHETIC CHAIN

The methods of intervention suggested for suppression of the sympathetic innervation of the eye are: (1) resection of the superior cervical ganglion (Meighan¹⁵), (2) sympathectomy performed on the carotid ganglion (Magitot and Desvignes¹⁵) and (3) resection of the cervicothoracic sympathetic ganglion, or stellectomy (Royle, Frazier and Caeiro).

These three methods of intervention, apparently similar, differ fundamentally in the intensity and duration of the effect.

Place Chosen for Operation.—Present day knowledge shows that when the sympathetic paths to the head, neck and upper limb separate from the tractus intermediolateralis they concentrate in the cervicothoracic, or stellate, ganglion, the result of fusion of the third cervical ganglion with the first thoracic ganglion. From this point the sympathetic fillets go toward the head in three ways (1) by way of the carotid chain formed by the plexus of both carotid nerves, the internal and the external; (2) by way of the sympathetic trunk and its cervical, middle and upper ganglions, which end in the cavernous plexus, and (3) by way of the spinal nerve that runs in the direction of the spinal artery, ending in Willis' circle, in the arteries of the rear part of the brain and in the branches of the optostriate nucleus.

According to the diagram (fig. 1), it will be seen that sympathectomy performed on the carotid ganglion, as well as resection of the upper cervical ganglion, in comparison with stellectomy must be considered as segmentary sympathectomy, and its value is less in reference to the elimination of the number of sympathetic fibers.

Sympathectomy on the superior cervical ganglion performed in association with sympathectomy on the carotid ganglion does not destroy totally the sympathetic innervation of the eye.

15. Magitot, A., and Desvignes: Les effets oculaires de la décortication carotidienne (sympathectomie artérielle) chez l'homme, Bull. Soc. d'opht. de Paris, March 1934, p. 143.

Besides, on another occasion we have shown that sympathectomy of the carotid ganglion, by provoking incomplete destruction of the sympathetic fibers, can produce the opposite of the desired effect, that is, excitation of the sympathetic function, which would naturally produce constriction of the ocular vessels, an effect totally different from the one sought.

The stellectomy praised by Royle and by us, which is classified by Americans as a "low" operation, is anatomically and functionally the

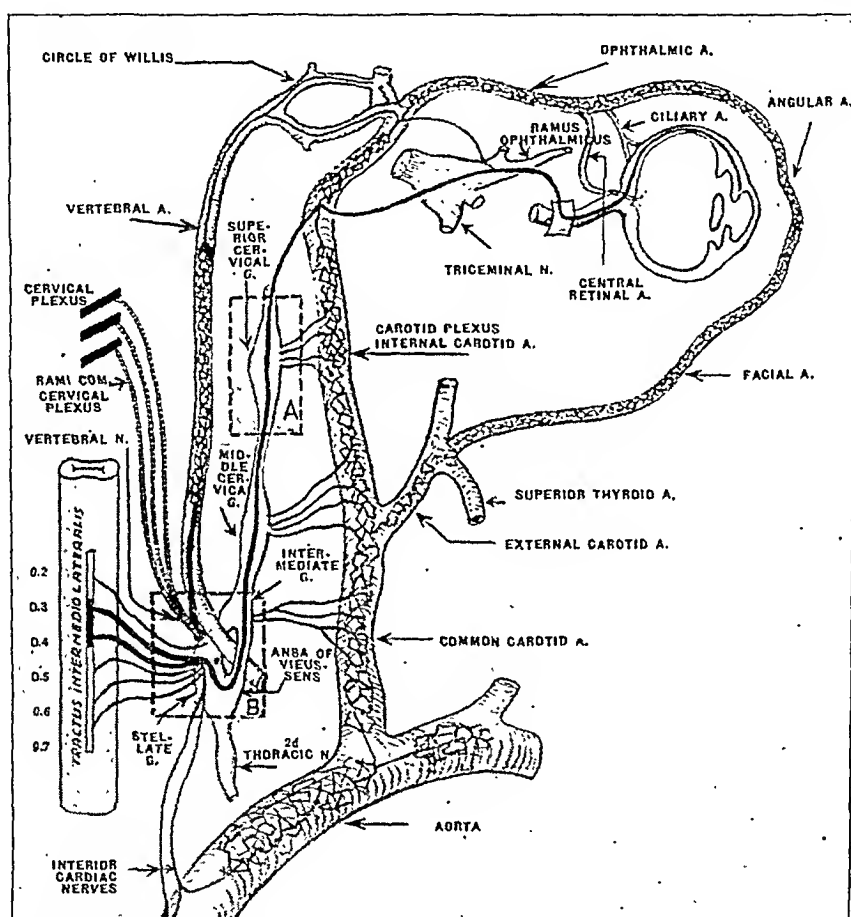


Fig. 1.—Sketch of the sympathetic pathways of the eye. *A* illustrates segmentary sympathectomy, or resection of the upper cervical ganglion, and *B*, stellectomy, or resection of the cervicothoracic ganglion, a more complete operation.

exact intervention to attain the maximum of effect by total destruction (within the present day knowledge) of the sympathetic innervation of half of the head. I place much value on, and systematically perform, resection of the spinal nerves, which in some cases of thick intermediary ganglia that may be confused with the mass of the stellate ganglion may escape cutting (section).¹⁶

16. Caeiro, J. A.: La estelectomía, *Semana méd.* 1:557 (Feb. 21) 1935.

I perform section of the connection of the stellate ganglion and of the second dorsal nerve a little high in order to preserve as much as possible the greater part of the rami communicantes that go toward the last cords of the brachial flexor muscle—the sixth, seventh and eighth—and the first dorsal nerve, as these are not necessary for the purpose, also avoiding useless sacrifice of part of the sympathetic innervation of the upper limb.

Stellectomy is an operation that must be closely controlled by the surgeon to avoid failure due to poorly performed or incomplete extirpation. Since it is a purely anatomic operation, search for the stellate ganglion may be easy in some cases, and may be very complicated in others, more so in those cases in which fusion of the inferior cervical ganglion with the first thoracic ganglion is incomplete. A surgeon of little experience may easily make the mistake of extirpating what looks like the stellar ganglion and what really belongs to that bulkiness known as the intermediate ganglion. Extraction of this ganglion will be an incomplete operation, for the stellate ganglion and the spinal nerve will not have been touched. Of course the failure in these cases cannot be considered as due to the method applied but must be thought of as due to the defective technic employed.

Claude-Bernard-Horner's syndrome, which unavoidably must occur, no matter how high the sympathetic trunk and Vieussens's ansa, that is the way that the iridospinal fillets take to reach the eye (fig. 1), are sectioned, must not be taken as a sign that the stellectomy and the section of the spinal nerve have been performed correctly or as indicating a good prognosis, as some mistakenly interpret it.

Incomplete resection in which the lower part of the stellate ganglion and the beginning of the spinal nerve are left will be accompanied by Claude-Bernard-Horner's syndrome, but for the desired purposes it will be a poorly performed and ineffective operation.

On the other hand, the absence of Claude-Bernard-Horner's syndrome after the operation means a poorly carried out operation, as the sympathetic chain has not been sectioned.

Therefore we have already remarked that this operation must be strictly controlled by the surgeon in order to draw useful deductions from the results, unsuccessful as well as successful.

Side on Which Operation Is Performed.—There is no special factor that determines definitely the side to be chosen for the intervention.

Nevertheless, if one considers the relationship, with the effect desired and the modifications that one strives to attain when one changes the trophic state of the neuro-epithelium and modifies the state of the circulation, choroidal and retinal, naturally the side chosen must be that on which the patient shows keener and better sight.

The retina with better function will show a smaller degree of atrophy than the other retina, and of course the effects sought will be more intense in a retina with good function than in a retina that has lost all function. In any case the effects are felt on the opposite side, though in a minor degree.

The results that my associates and I have obtained following this idea appear to us to be safe, as we place ourselves in a position to work on the retina that has the fewer functional and anatomic injuries.

OCULAR MODIFICATIONS

The ocular modifications obtained were: first, those dependent on the suppression of the sympathetic innervation; second, those due to the changes in the optic function, and, third, those due to the contralateral ocular modifications.

1. In all our patients stellectomy has immediately called forth Claude-Bernard-Horner's syndrome. The regular appearance of this syndrome is due to the severing of the fillets going to Müller's muscle and to the elevator muscle of the upper eyelid. The absence of this syndrome after stellectomy means that the operation has been performed incorrectly.

Enophthalmos and miosis vary according to the patient. The vascular expansion that takes place a few minutes after the operation becomes distinct after eight or ten hours, reaching its full intensity within twenty-four or thirty hours. It lasts three or four days, though in some cases we have noticed that it was intense during a week and afterward gradually diminished until it disappeared within fifteen or twenty days. We have noticed an interesting fact that may be taken as of prognostic value: The greater the conjunctival vascular expansion, the more favorable will the outcome be in most cases.

2. The changes in the optic function are seen in two fundamental phenomena: (*a*) modifications in visual keenness and (*b*) modifications in the visual field.

a. Generally, visual keenness, except in the patients in whom the injuries were very advanced and who were operated on in order to prove how much it could be modified (persons who were almost blind), has shown an increase in most cases. Sharper sight has appeared in the eye on the side operated on, and we believe that this was due to performing the operation on the side on which sight was keener.

This increase in visual keenness has been as variable in intensity as the time of its appearance. It has generally appeared within the first twelve or twenty-four hours. The patients noticed it especially at night, when they remarked a greater brightness in the electric light bulb and an absence of the mistiness that they were in the habit of seeing.

In some cases the visual keenness remained stationary and later increased slowly but progressively within the first month. In other cases it reached the maximum a few days after the operation, vision being doubled or trebled. Only one patient, after three months, lost much of what he had gained, but nevertheless his vision remained better than it had been before the operation.

In some cases, though in a very irregular way, improvement in visual keenness, though variable, appeared on the side opposite the one on which the operation was performed.

It has been proved that the greater the congestive and heat reaction of an eye, the quicker the increase in visual intensity. This fact shows clearly the beneficial action of a better retinal circulation.

One can practically consider that increase of visual keenness, in spite of the fact that it takes place within variable limits, is almost constantly seen after the operation when this is performed on a patient who has not reached the point of seeing only bulky objects.

b. The visual field also undergoes modifications, although they do not occur with as much regularity as increase in visual keenness. The field nearly always shows an increase of from 10 to 20 degrees, and in only one case (observation 7 of Caeiro, Malbrán and Balza²) was a considerable increase achieved.

According to the way in which we think stellectomy acts, through modification of the circulatory condition and cellular trophism, improvement of the visual field is made possible because of the better cellular nourishment. A phenomenon takes place similar to that observed in Volkmann's ischemia in certain types of thrombo-angeitis of the lower limbs and even in angina pectoris, in which, provided the anatomic injury of the cells has not led to final atrophy, operation on the sympathetic chain can modify the condition and bring about improvement of these ailments.

When cellular disturbances are definite, operation on the sympathetic nervous system is absolutely useless.

This fact of great importance must be taken into consideration in order not to attach the blame for failure to sympathectomy when this operation has been suggested too late.

The retina cannot escape the effects of general pathologic changes, and whether these effects are degeneration of the neuro-epithelium, narrowing of the light reflex of the retinal vessels through proliferation of the conjunctival tissue or disturbances of vascular type, operation on the sympathetic chain may be useful when practiced early, allowing an increase in the circulation of the retina. This will produce a favorable reaction that will show in a better metabolism and cellular activity and consequently better function, that is to say, better sight.

If, on the other hand, the operation is performed too late, little or nothing can be achieved, for the retina is anatomically and functionally lost.

3. *Contralateral Ocular Modifications.*—My associates and I have remarked the beneficial influence of the operation on the function of the retina of the opposite side in four cases and its manifestations as regards, in the first place, visual keenness and, in the second place, the visual field.

The phenomena observed took place immediately after the operation or within fifteen or twenty days or even later. The patients drew our attention to this improvement, and in the beginning we thought it might be based on imagination, but later, when the visual keenness was controlled, it was seen that vision really increases.

What mechanism can explain these facts? To leave the ocular sphere and to enlarge on the phenomena that are seen immediately after the operation on the sympathetic system, frequently one sees effects that appear to be due to suppression of the sympathetic innervation on the side opposite to the one on which the operation has been performed. We have been able to prove this, and Royle⁵ has also drawn attention to the effects of severing a branch in spastic paralysis. On one occasion, in a patient on whom we performed sympathectomy of the femoral nerve, we noticed increase of oscillations and temperature in the limb on which the operation was not performed. We also have had a chance to remark phenomena of paralytic vascular expansion after stellectomy on the side on which the operation was not performed.

The crossed sympathetic innervation and the anastomosis between the hips are a feasible explanation for these phenomena, so far as the lumbar portion of the sympathetic system is concerned, but in the cervical chain, within the present day knowledge, there is independence between the right side and the left side (Caeiro¹⁷).

We attach importance to the appearance of these phenomena after resection of the spinal nerve, which, when it is done in a complete manner, can destroy part or all of the plexus that accompanies the trunk of the basilar artery and which can influence the paralytic vascular expansion of the choroidal circulation of the sound side through production of partial destruction, or maybe phenomena of functional inhibition also intervene.

The truth is that one cannot give a satisfactory explanation of these phenomena with the present day knowledge. Neither can the anatomic features of the sympathetic system that the knife discloses give such

17. Caeiro, J. A.: Resultados de la estelectomía en la parálisis traumática del nervio facial, Bol. y trab. de la Soc. de cir. de Buenos Aires **19**:392 (June 26) 1935; *Semana méd.* **1**:572 (Feb. 20) 1936.

an explanation. Possibly they are phenomena of correlation of functional order due to an unknown anastomosis of which only the physiopathologic characteristics of this system, as one goes deeper into the study, will give a more definite explanation.

GENERAL MODIFICATIONS RESULTING FROM STELLECTOMY

The alterations that stellectomy produces by destroying extensive zones through which the peripheral portion of the sympathetic system is distributed cause disturbances that vary in intensity and in duration.

Vasomotor Alterations.—These have generally been temporal and have been associated in a greater degree with changes in the weather, with sudoriferous disturbances and with pilomotor phenomena. These changes have been variable, and some have been more emphasized than others, but generally they have soon disappeared.

With more regularity violent headaches of congestive type have occurred, sometimes persisting during the first few days after the operation; in only one patient have we seen them reappear from time to time and lasting a very short while.

Pain.—Some American authors have stressed the occurrence of pain. This is of two kinds: that which starts in the precordial region and crosses to the level to the spinal edge of the omoplate and that which occurs in the upper limb. The first kind of pain usually disappears quickly. On the other hand, pain in the upper limb occurred in the first cases in which my associates and I extended the resection almost to the second thoracic ganglion, in such a manner that the branch communications to the branchial plexus were completely destroyed; today we have partly modified our operation and have reduced it to extirpation of only the stellar ganglion and particularly to resection of the spinal nerve; this type of pain has hardly ever appeared with this procedure, as part of the sympathetic innervation of the upper nerve is not touched.

In the few cases in which there has been pain it has been temporal and has been confined to the deltoid region and the root of the shoulder. As to the pain in the neck and head, this corresponds more to the cephalaea already mentioned.

Cardiac Disturbance.—This has been one of the most important objections made to stellectomy. In all our patients with a sound cardiovascular apparatus my associates and I have not remarked any alteration that could upset the normal cardiac function, even in a case in which stellectomy was performed bilaterally. This has led us to believe that the objection is based more on theory than on fact, and it does not find confirmation in the results of the finest methods of investigation of the cardiac function. We have taken the precaution of making an

electrocardiogram for all our patients before and after the operation, and electrocardiograms have also been made later. None of these electrocardiograms has shown disturbances of waves or conduction, and the latter have kept within normal limits, even in the cases in which stellectomy was performed bilaterally.

These results are evident facts that we do not pretend to explain, but they have a certain importance, and we feel justified in believing, maybe somewhat empirically, that stellectomy practiced on patients who have the cardiac apparatus undamaged will cause little disturbance through the suppression of the sympathetic innervation.

RESULTS

The patients for whom operative results can be reported may be divided into two series: The first series consists of thirteen patients operated on without consideration of the degree of progress of the ailment. In some of the patients of this group the malady was so far advanced that they could practically be considered blind. The decision to operate was made expressly to see how stellectomy could modify the condition.

The results already published¹² are those for four patients who had a great increase in the visual field and in visual keenness, which still persists. One patient who obtained much improvement in visual keenness and in his field lost within six months almost all that he had gained; a slight improvement of visual keenness nevertheless persisted.

In four patients only a slight improvement in visual keenness was obtained, and lastly, in four others there was no change.

The good results in the first four patients can be considered well proved. One of these was operated on in March 1933. His improvement was very marked and allowed him to return to his work. This patient came back some time later and requested us to operate on the opposite side, in view of the good result of the first operation. He was operated on in 1936 and did not obtain more benefit than that already obtained through the first operation.¹⁸

The second series includes selected patients, that is, those in whom the malady was not very advanced or at least whose visual keenness permitted some degree of useful sight. All these cases are unpublished cases; the patients were operated on in 1936, with very satisfactory results.

REPORT OF CASES

CASE 1.—The patient was M. B. H., a married Argentine woman 30 years of age. Her father had died of heart disease at 67 years of age. Her mother was still alive and was in good health. The patient had seven brothers. One

18. Caeiro, J. A.: Retinitis pigmentaria, *Bol. y trab. de la Soc. de cir. de Buenos Aires* 19:1131, 1935.

of them had pigmentary retinitis; the rest were well. The patient had had no abortions and had two healthy children. As far back as she could remember she had had pigmentary retinitis, with hemeralopia. She was well built, strong and in perfect physical health. An electrocardiogram was normal.

Visual keenness before operation was $1/3$ for the left eye and $1/4$ for the right. The visual field of the left eye, as determined with a 3 mm. test object at a

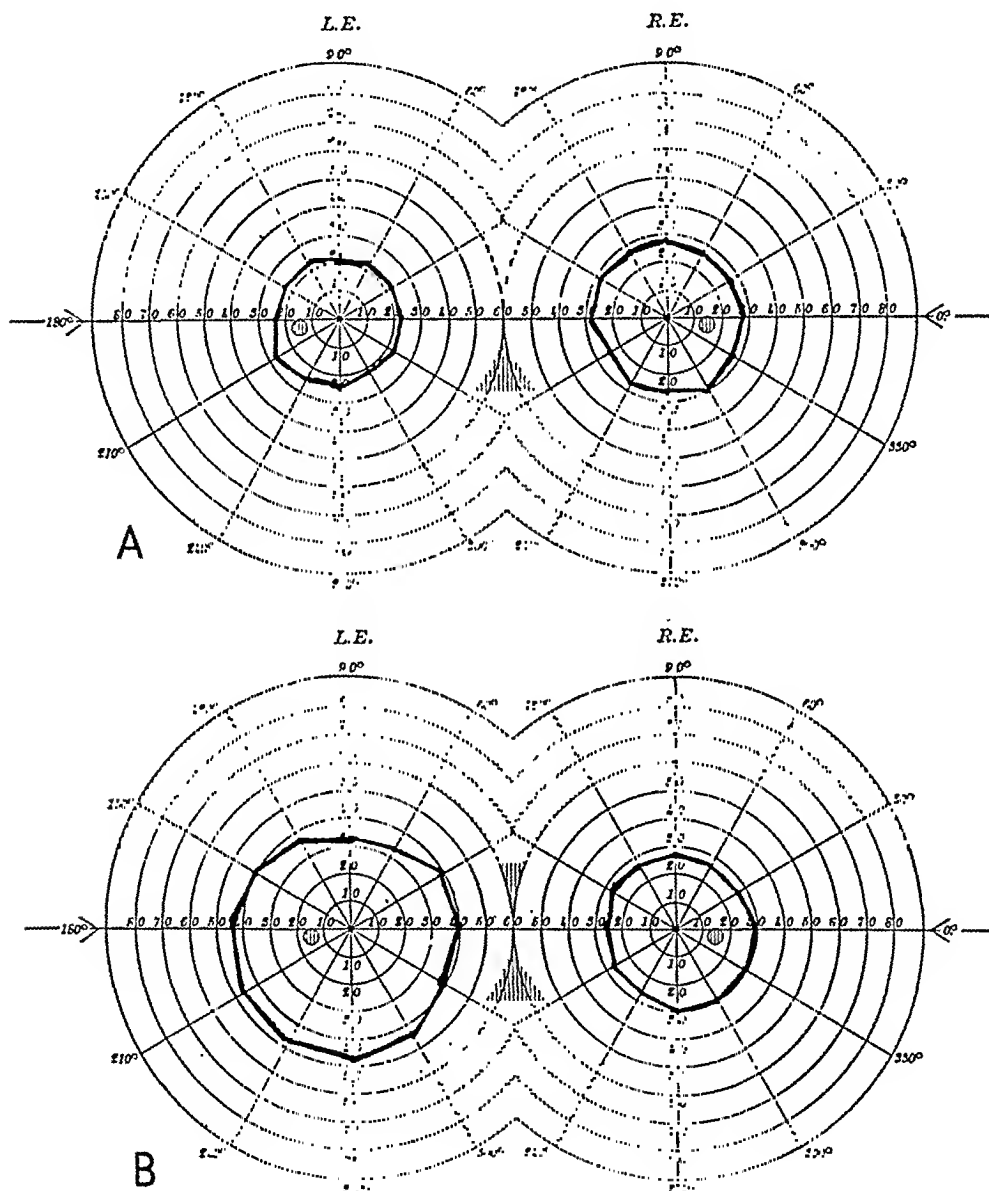


Fig. 2. (case 1).—*A*, fields before operation, on Aug. 16, 1936, as determined by a 3 mm. test object at 330 mm. Vision of the left eye was $1/3$ and that of the right eye $1/4$. *B*, fields after operation, on October 16, as determined by a 3 mm. test object at 330 mm. Vision of the left eye was $1/2$ and that of the right eye $1/4$.

distance of 330 mm., was contracted to 20 degrees and that of the right eye, as determined similarly, was contracted to 25 degrees.

Stellectomy was carried out on the left with our usual technic, in September 1936.

After the operation the condition was normal. On examination on Oct. 16, 1936, the visual keenness of the left eye (the eye on the side operated on) was $1/2$, and the visual field, as determined with a 3 mm. test object at a distance of 330 mm., extended both nasally and temporally to 40 degrees.

This patient's progress was most satisfactory; the visual disturbances at night became less pronounced. When examined in January 1937 she still showed improvement. The electrocardiogram taken at this time showed nothing of import.

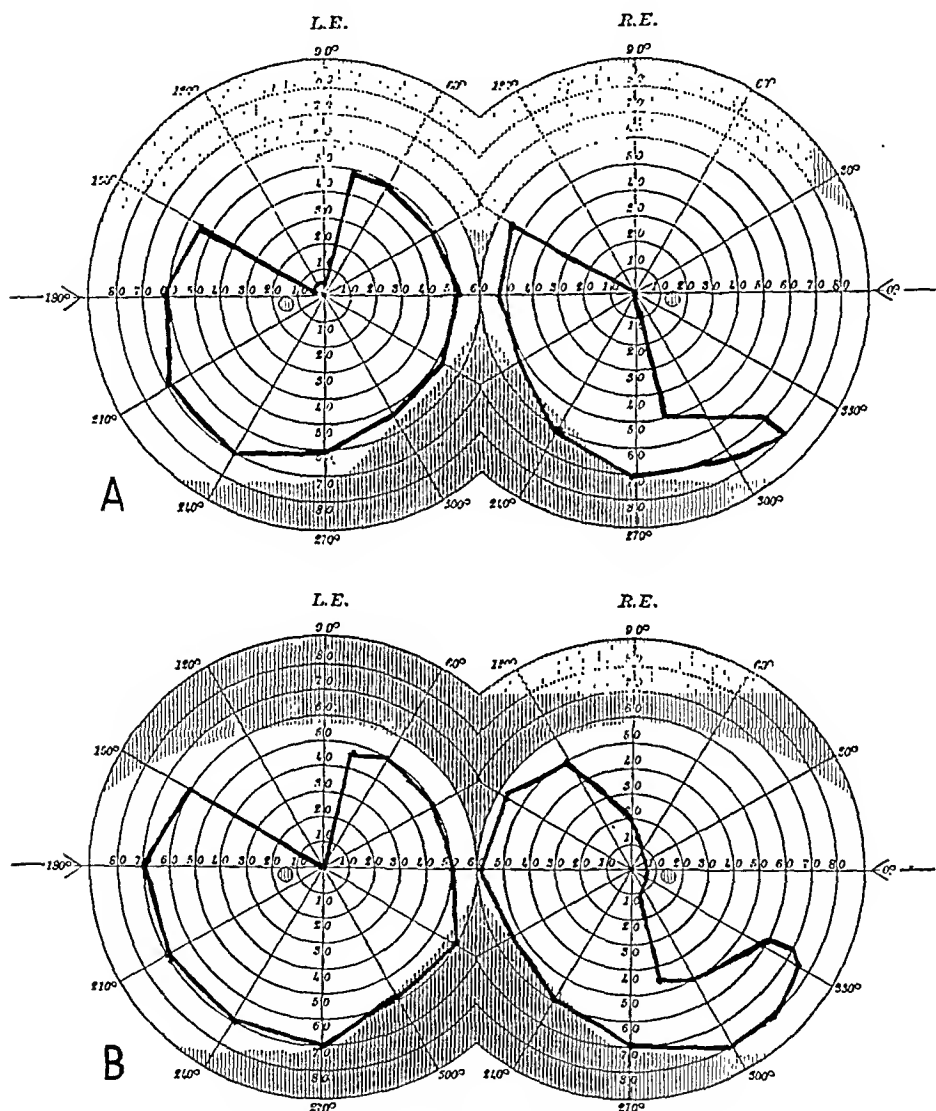


Fig. 3 (case 2).—*A*, fields before operation, on April 17, 1936, as determined by a 3 mm. test object at 330 mm. Vision of the left eye was $1/5$ and that of the right eye $1/4$. *B*, fields after operation, on October 26, as determined by a 3 mm. test object at 330 mm. Vision of the left eye was $1/3$ and that of the right eye $1/2$.

CASE 2.—L. G., a married Polish man 47 years of age, had hereditary and personal antecedents of no importance. No member of his family had suffered from pigmentary retinitis. His malady began two years previously with loss of

vision, particularly at night, with marked diminution lately. He could not get along alone and could hardly distinguish very large letters.

On April 17, 1936, examination of the visual field of the left eye with a 3 mm. test object at a distance of 330 mm. showed contraction to 50 degrees in the nasal fields and to 70 degrees on the temporal side.

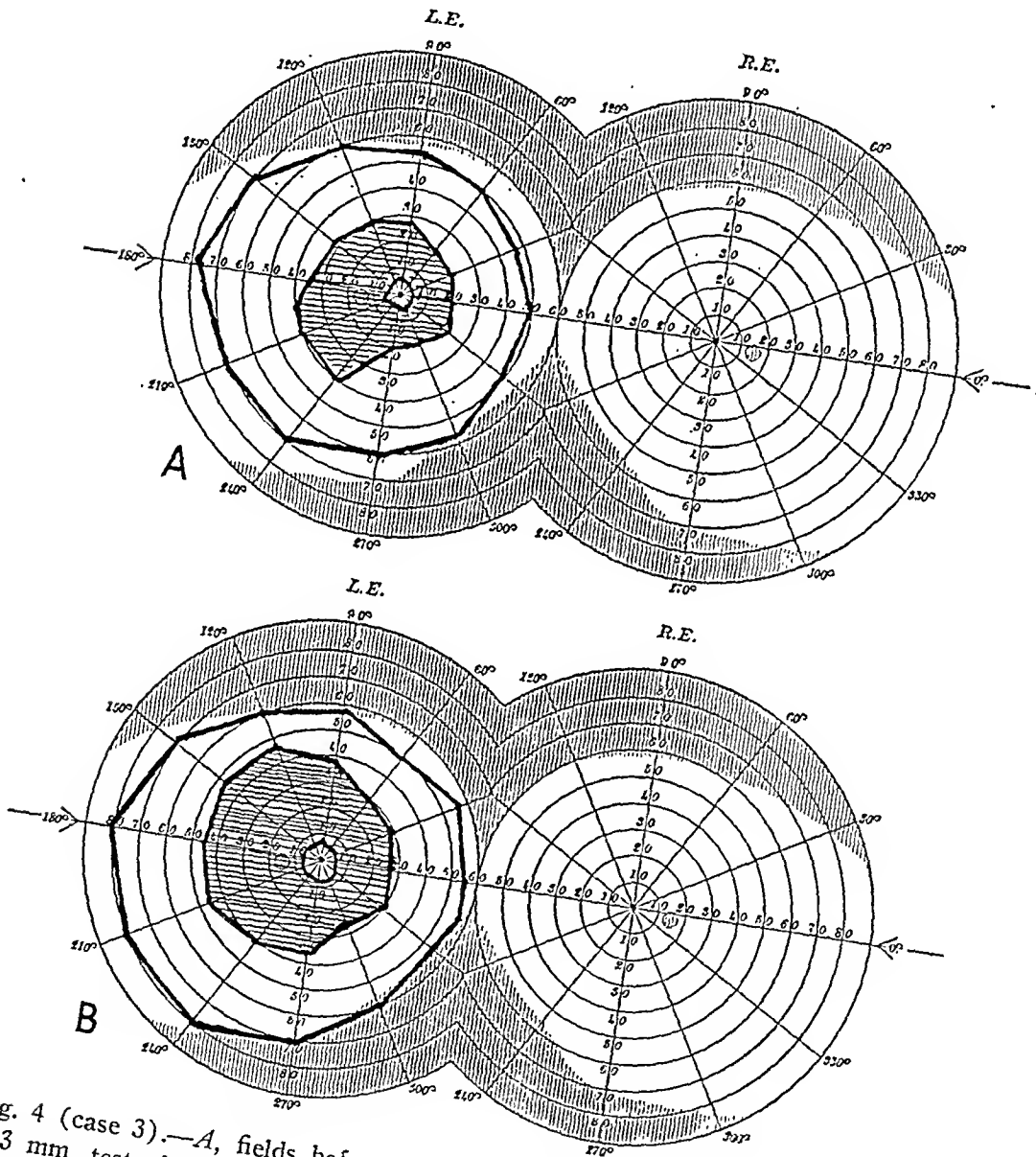


Fig. 4 (case 3).—A, fields before operation, on June 30, 1936, as determined by a 3 mm. test object at 330 mm. Vision of the left eye was 1/10 and that of the right eye 0. B, fields after operation, on October 27, as determined by a 3 mm. test object at a distance of 330 mm. Vision of the left eye was 1/6 and that of the right eye ability to distinguish bulky objects.

The visual keenness was 1/5. The visual field of the right eye, as determined with a 3 mm. test object at a distance of 330 mm., was contracted on the nasal side to 60 degrees, the extension on the temporal side being 0.

The visual keenness was 1/4. The electrocardiogram taken before the operation showed nothing important.

On May 5 stellectomy was carried out on the right. The immediate results were very good, visual keenness increasing so much as to allow the patient to read and to get along by himself. The electrocardiogram made after the operation was normal.

Examination of the visual keenness made in October showed vision of $1/3$ for the left eye, and vision of $1/2$ for the right. The visual field of the left eye

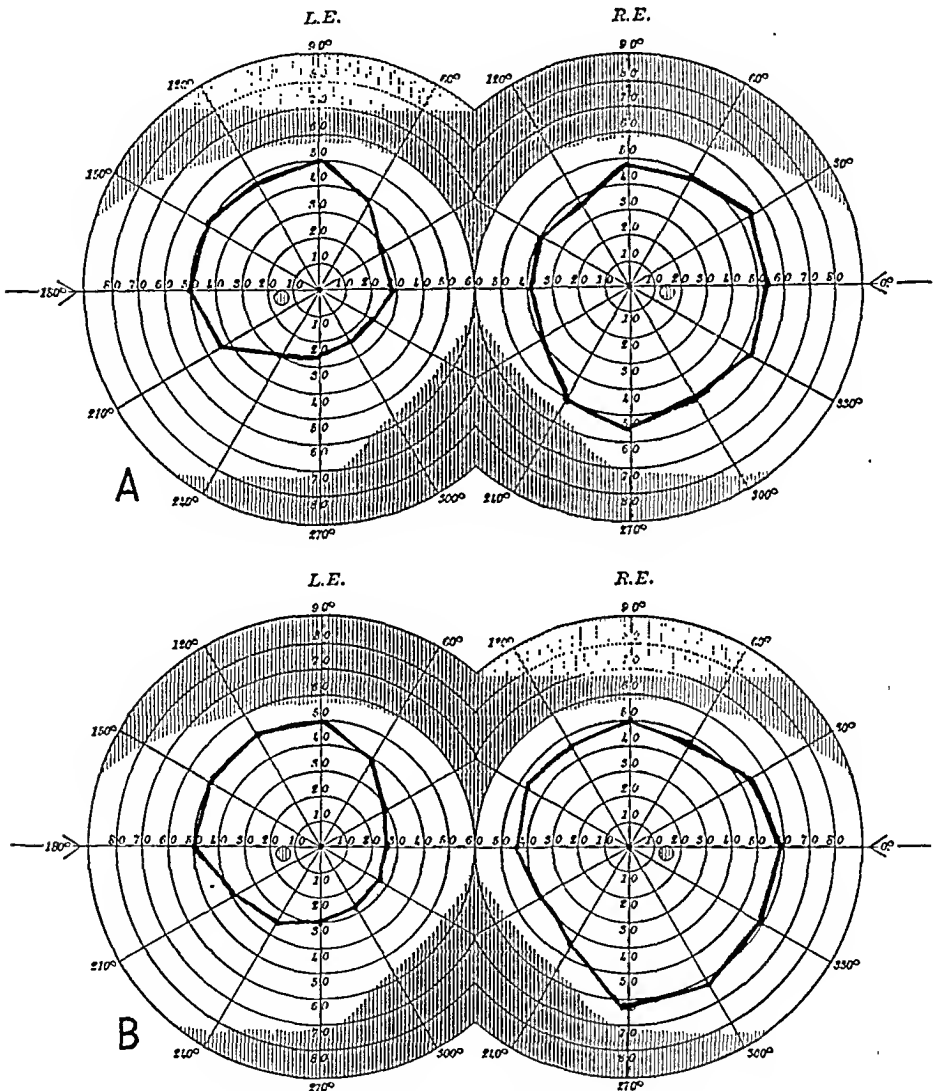


Fig. 5 (case 4).—*A*, fields before operation, on May 8, 1936, as determined by a 5 mm. test object at 330 mm. Vision of the left eye was perception of fingers at 3 meters and that of the right eye $3/10$. *B*, fields after operation, on October 26, as determined by a 5 mm. test object at 330 mm. Vision of the left eye was perception of fingers at 3 meters and that of the right eye $1/2$.

remained within the same limits as previously, but that of the right eye had increased in the temporal zone to 50 degrees.

In this patient the contralateral effects were amazing.

When examined on Jan. 5, 1937, he was found to be doing well, and he has returned to his work.

CASE 3.—The patient was J. W., a married Polish man 48 years of age. The father was dead, the cause of his death being unknown to the patient. The mother was alive and healthy. The patient had five brothers, all healthy, and had two healthy children. The patient had no ancestors who had had pigmentary retinitis. His malady began twenty years before; his sight had diminished gradually, and at the time of examination he could see only bulky objects and had been forced to abandon his work.

Ophthalmoscopic examination on June 30, 1936, showed visual keenness to be 0 in the right eye and 1/10 in the left. Determination of the visual field of the left eye with the use of a 3 mm. test object at 330 mm. showed a central area, with a peripheral zone extending between 25 and 55 degrees. An electrocardiogram made before the operation was normal.

On July 3 stellectomy was carried out on the left with the usual technic.

The next day the patient was able to distinguish the separation between letters, whereas before he could see only one continuous black line. Two days later he saw clearly the objects within reach of his hand and could read the posters on the wall. He was now able to walk alone.

Ophthalmoscopic examination on October 27 showed the visual keenness of the left eye to be 1/6 without correction and that of the right eye ability to distinguish bulky objects. The visual field had increased in the central and peripheral portions. An electrocardiogram was normal.

An examination was made again in January 1937. The improvement had persisted, allowing the patient to work again and get along alone.

CASE 4.—J. S., a single Italian man 37 years of age, had antecedents of no importance. There was no pigmentary retinitis in his family. Since his childhood he had been gradually losing his sight, and this loss had been marked in the previous ten years. There was hemeralopia. A month before examination his sight diminished rapidly.

Ophthalmologic examination on May 8, 1936, showed that the visual keenness of the left eye had not been modified, and the patient could see fingers 3 meters away. The visual field of the left eye, as determined with a 5 mm. test object at a distance of 330 mm., was contracted to 50 degrees on the temporal side and to 25 degrees on the nasal side. The visual field of the right eye, as determined similarly, was contracted to 50 degrees on the temporal side.

Operation was performed on the right on June 4, 1936; there were no immediate results.

The patient was examined again in October, when the ophthalmologic examination showed visual keenness of the right eye to be 1/2 with correction. The visual field of the left eye, as determined with a 5 mm. test object at a distance of 330 mm., was still contracted to 50 degrees on the temporal side.

The patient had improved very much. An electrocardiogram was normal.

Lately we have treated four more patients with this method, with good results, but owing to the short time that has elapsed since the operation we have not included the report of these cases here.

SOME NEWER DEVELOPMENTS IN PRECISION TYPE STEREOSCOPES

EMANUEL KRIMSKY, M.D.

BROOKLYN

Before describing some of the mechanical details of two new instruments to be presented here, it may be well to discuss briefly the reasons which prompted me to venture into creating and designing such devices as well as the principles favoring their uses.

The tendency of subjecting persons with supposed or actual muscle anomalies to orthoptic training solely on the basis of routine ocular study did not appear satisfactory, because one could not accurately or conveniently adjust the stereoscope to correspond to one's clinical findings. It seemed logical that an instrument designed to correct a binocular disturbance should also provide a definite means for gaging progress or improvement, which, in addition, might be used to determine both qualitatively and quantitatively the status of the eyes, so that the examiner could accurately decide whether the patient really required orthoptic training or just impressive ocular calisthenics. Hence, an optical instrument that is therapeutic would better meet critical standards if it could also be diagnostic or recording. In other words, a routine clinical study supplemented by an instrumental investigation should be the prerequisite to orthoptic training.

It seemed reasonable to understand first the normal binocular changes when one looked into a stereoscope; to be able to explain why certain separations of the split stereogram or the viewing distance proved comfortable and other positions induced diplopia. And so, before even constructing an experimental model, the various binocular phenomena induced by changing the viewing lenses and altering the lens separation, the viewing distance or the interstereogram separation were calculated on paper and subjected to experimental and clinical confirmation on normal as well as on abnormal subjects. These studies as well as the experimental model formed the basis of a contribution to the 1935 Scientific Exhibit of the American Medical Association and were more recently reported elsewhere.¹

In short, this research revealed a few basic principles:

(a) The eyes cannot maintain the same pupillary separation with changes in the viewing distance.

1. Krinsky, Emanuel: *The Stereoscope in Theory and Practice*, Also a New Precision Type Stereoscope, *Brit. J. Ophth.* **21**:161-197 (April) 1937.

(b) As the eyes converge with accommodation, the interstereogram separation must be made correspondingly less in order to maintain easy fusion.

(c) A split stereogram which could be shifted to correspond to changing positions of the visual axes with changing accommodations is the only practical method for stereoscopic study.

(d) A stereogram with separation fixed for infinity viewing range becomes relatively divergent when brought nearer the eyes.

(e) The variable convergences of the eyes with changing accommodations can be accurately calculated and applied to stereoscopic investigation.

In order to be of practical value for the purpose described, the stereoscope should meet the following requirements:

(a) It should be calibrated in every respect so that the examiner can have absolute control in the selection of viewing lenses, lens separation, viewing distance or interstereogram separation.

(b) The instrument should be devised so that the examination will not be too time consuming.

(c) It should have psychologic appeal to both the examiner and the patient.

(d) It should be elastic in scope, not only as regards lateral ductions and phorias but as regards vertical and rotary ductions and phorias. (My instrument was even provided with a stereocampimetric attachment.)

(e) It should be a mechanically refined precision instrument that can yield reliable numerical readings.

(f) It should enable the examiner to observe readily the eyes of the patient without attracting the latter's attention.

(g) It should be simple to operate and require as few basic pictures or targets as possible to serve its purposes as a diagnostic as well as a therapeutic instrument.

My experimental model was further improved and modified to meet these requirements. In short, I aimed to improve the familiar Brewster stereoscope much as Howard, Pugh, Maddox and others have so well done with the more primitive Worth amblyoscope.

The value of a calibrated, or phorometric, stereoscope as a clinical instrument can be dealt with at length and will form the basis of a separate paper. A precision stereoscope enables the examiner to determine readily the divergence and the convergence status of the eyes both at infinity and at any desired range of accommodation and thus to diagnose and classify the type and degree of muscle anomaly. He can also determine the total range of fusion as well as of its component phases, adduction and abduction; the amount of phoria; the vertical and rotary

status as well as the horizontal status; the measurement of false projection, if any; the measurement of lateral as well as vertical deviations, and the progress at each sitting in terms of prismatic vergence.

While such an instrument could serve the purposes of a diagnostic as well as a training instrument, for the sake of economy and portability a junior, or companion, stereoscope was more recently developed, primarily as a home-training unit or one to be readily taken back and forth to the clinic. A separate description of each instrument may better explain the need for such an addition, and the two instruments will be described under the following headings: (1) senior model, or phorometric stereoscope (fig. 1), and (2) junior model, or companion stereoscope (fig. 2).

SENIOR MODEL, OR PHOROMETRIC STEREOSCOPE

The senior stereoscope (fig. 1) presents the following features:

(a) The viewing head consists of a simple, sturdy lenseless trial frame with compartments for two sets of trial lenses as well as multiple spring holders for the free insertion of supplementary square prisms. This frame may be readily adjusted to a lenticular separation that can be varied from 52 to 90 mm. The lens holders are calibrated to permit the insertion of cylinders at any desired axes. Thus, an ametropic correction may be added to the viewing lenses to determine the binocular status before glasses are prescribed.

(b) One of the connecting, double rods between the viewing boxes and the viewing head is marked off in centimeters and not in accommodation equivalents, so that the examiner may feel free to employ whatever strength lenses he chooses in the viewing head. The viewing distance may be readily changed from 12 to 40 cm. by the simple turning of a rack and pinion screw. This wide range permits flexibility in the selection of lenses for different requirements.

(c) The viewing boxes, or carriers, are designed to receive transparencies and solid objects as well as opaque prints. Whereas in the familiar stereoscope fixed stereograms are in the main relied on, in my instruments I employ split pictures which permit flexibility in movement and control in operation through the riding of both boxes simultaneously over a two way thread. This is accomplished by turning a handle which is placed conveniently within reach. The thread chosen is such that each complete turn of the handle moves each picture through a distance of 1 mm. Thus the operator is saved frequent inspections of the viewing scales.

(d) For purposes of precision, the position and lateral displacement of the split pictures or objects may be readily noted by means of an adjustable pointer which intersects two millimeter rules: a lower one

that is fixed and has the zero at its septal margin with the graduations increasing to the right and an upper slide rule that has its zero point at the center with graduations increasing from both sides of the zero. This rule moves with the movement of the boxes after its zero is set to the center or selective point of whatever size picture is employed.

In a precision stereoscope the exact separation of the pictures is important in relation to the known separation of the viewing lenses as

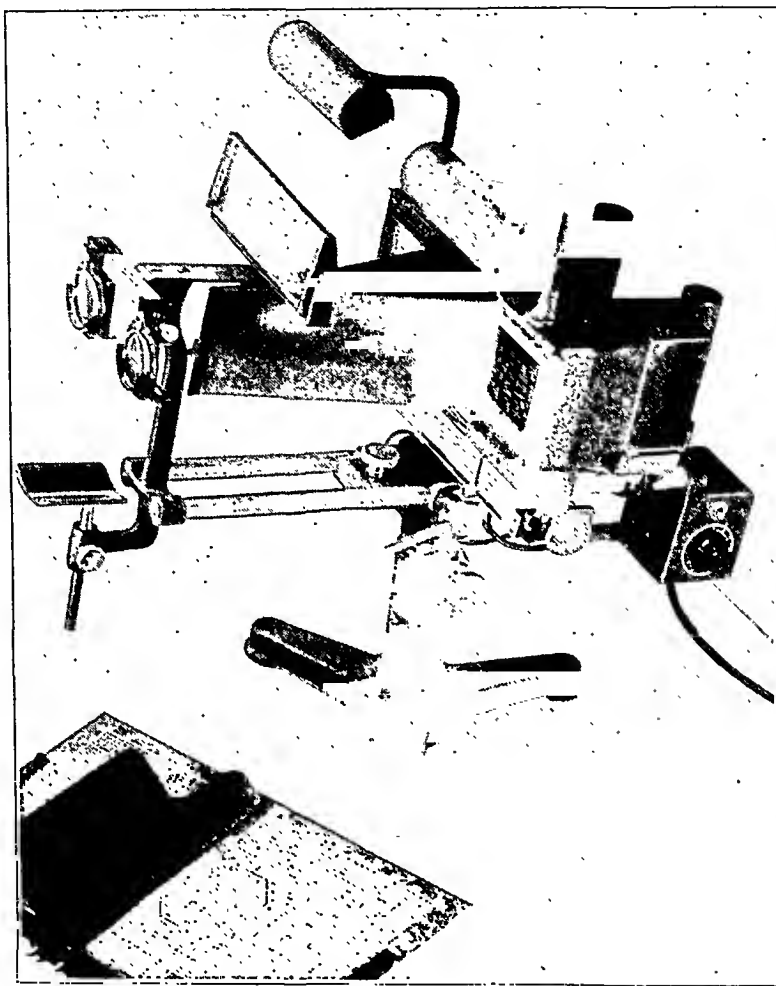


Fig. 1.—The senior, or phorometric, stereoscope (minus the adapters). This photograph is not retouched.

well as of the viewing distance. If the viewing lenses are set for infinity (their focal length), they would have to be separated from center to center by the same amount as the centers of the stereoscopic pictures in order to render the visual axes of both eyes parallel or to register in normally functioning eyes a single fused image for far vision. If, for example, the lenses are set at the 80 mm. separation (40 mm. from the midline), the center of the picture would likewise have to be set at 40 mm. on the lower fixed rule for this primary or parallel position. If

40 mm. on the fixed rule is selected as the starting point for operations, the pointer is set over the 40 and the center of the picture brought in line with it; the upper slide rule is then shifted with its zero between the 40 and the center of the picture. In this way, whatever displacement is made in the viewing boxes, either internal or external to the primary position for far vision, is determined by the displacement of the movable rule in relation to the adjustable pointer, which remains set over 40 mm. on the fixed rule. One may wish to determine the capacity of the eyes to maintain single binocular vision in the abduction phase or in the adduction phase. In either case the boxes are shifted until there is a break in the images, and then the reading is made on the slide rule in terms of millimeters. By means of a ready reference card this is readily translated into prism diopters and is recorded as the "breaking point." The boxes are then gradually brought back toward the primary position until a single binocular image is obtained, and this is likewise translated in terms of diopters as the "recovery point." And so one can graphically record for both the abduction and the adduction phase the respective "breaking points," which added together mean amplitude of fusion; one can also determine the "recovery points." The significance of such readings will be dealt with separately.

It is to be emphasized that the 40 mm. setting was merely arbitrary, and by means of simple tables the operator may at random vary the lenses, the lens separation or the viewing distance and readily make his translations. It is also to be emphasized that because eyes converge with accommodation the calculated primary positions or picture centers are not the same within infinity range as they would be at the focal length of the lenses. Here, too, the variable primary settings, with different ranges of accommodation, may be easily determined from such a table. And, finally, the element of interpupillary separation can be ignored for reasons discussed in a previous article.

For testing vertical or rotary phorias and ductions, suitable adapters may be inserted and manipulated to yield desired readings.

(*c*) The precision stereoscope offers the examiner and his patient a variety in the choice of stereoscopic material. Provision has been made by the means of suitable adapters for pictures of five different sizes: 45 by 45 mm., 60 by 60 mm., 75 by 75 mm. and 82 by 82 mm. (synoptophore slides) and in addition there is an adapter which holds both the Sattler and the Guibor split charts. The advantage of the smaller picture lies in its greater range of movement for both adduction and abduction. The larger picture is more appealing for its wider field of view. Moreover, the first three sizes were also chosen to correspond to the more popular sized stereoscopic cameras, so as to enable the examiner to make his own pictures if he so desires.

(f) Each viewing box has an independent lighting unit which operates both the lamp on the top of the box for opaque prints as well as the lamp within the box for transparencies. By a simple turn of the switch in the rear of the instrument, the light may be shifted to one or to the other. In this switch box are also independent rheostats to vary the intensity of illumination to the respective viewing boxes as well as independent flashers.

(g) One of the shortcomings in most examining or training instruments is that the examiner cannot see the patient's eyes follow the shifting of the pictures. This difficulty has been nicely overcome in my senior instrument by the incorporation of a tilted mirror, whereby inspection of the patient's eyes can be made without the patient being conscious of it. The mirror is conveniently set as to obviate unnecessary manipulations by the examiner, who faces both the mirror and the viewing boxes with its calibrations.

(h) The instrument has a collapsible telescopic double septum that is automatically adjustable to changing viewing distances. It consists of two opaque curtains which extend forward from respective rollers behind the corresponding viewing boxes. After hugging these boxes in such a manner as to guard against leakage of stray light when separated, the curtains continue forward to meet in front at the viewing frame, where they are attached. This septum may be readily released from its attachment when desired, so as to enable the examiner to insert a stereocampimetric attachment in a specially designed groove in front of the viewing boxes.

Additional refinements are provided, such as ready adjustment of the instrument in see-saw position for testing eyes in upward or downward gaze and raising or lowering the instrument proper.

One of the deficiencies in the ordinary stereoscope is that it is not suitably adapted to excessive degrees of squint. Such a defect may be corrected to a considerable extent by removing all unnecessary barriers in the viewing frame, by providing a more flexible range to the viewing distance and by the use of selective lenses in the viewer. As the unit displacement of the visual axis registers a greater prismatic value for near vision, the stereoscope may be adapted to more marked degrees of convergent squint with either lenses of short focal length (stronger plus lenses) for infinity or lenses of longer focal length for accommodative ranges. If, for example, plus 8 D. spheres are employed in the viewer at infinity range (12.5 cm.), this instrument could be readily adapted to convergent squint amounting to at least 60 prism diopters without the use of supplementary prisms and to divergent deviation of considerably greater amount.

JUNIOR MODEL, OR COMPANION STEREOSCOPE

The companion stereoscope (fig. 2) is, as its name implies, an accompaniment to the senior model. While it was primarily designed to serve as a refined calibrated home-training stereoscope, it is also intended, like the senior instrument, to function as a diagnostic instrument for use in the clinic, although less completely. When both instruments are available, the junior model may be readily adjusted to correspond to the disturbances revealed on the larger instrument, and exercises instituted accordingly. In this sense, it is intended for training purposes.

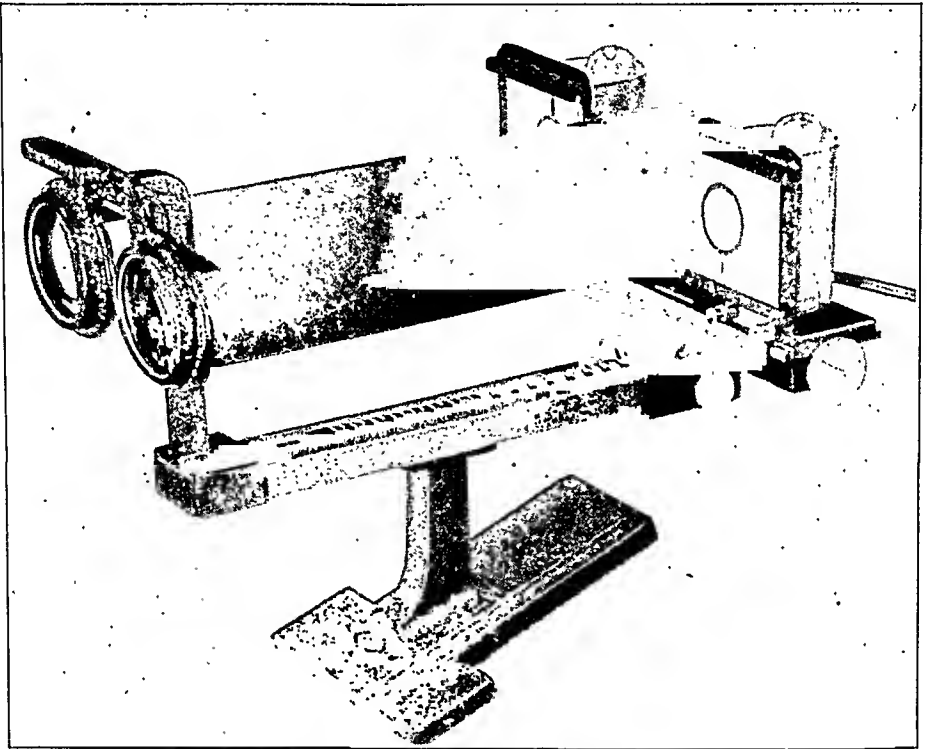


Fig. 2.—The junior, or companion, stereoscope. This photograph is not retouched.

Its features are as follows:

(a) Split pictures may be inserted into respective viewing boxes, which may be readily shifted toward or away from each other simultaneously by the turning of a handle that is placed conveniently within reach.

(b) The displacement of such pictures may be readily determined by noting the position of an attached pointer which rides with the picture carrier over a finely calibrated millimeter rule that extends from the septum laterally for a distance of 100 mm. While with the senior instrument the displacement of an adjustable slide rule that moves with the

picture carrier is noted in relation to the position of an adjustable stationary pointer and its setting over the fixed rule in order to obtain direct readings, with the junior model readings are made by noting the position of an adjustable pointer that rides with the picture carrier in relation to a single rule (fixed) and deductions are made accordingly. If, for example, the pointer (and picture) moves from an initial setting of 40 mm. to 50 mm., 10 mm. of abduction is recorded; if it moves from 40 mm. to 30 mm., 10 mm. of adduction is recorded.

This pointer, moreover, is adjustable to permit selective settings to correspond to smaller or decentered pictures (as in fig. 2) which travel over greater ranges of adduction or abduction.

(c) The viewing boxes, or picture carriers, are individual compartments, each holding a 25 watt candelabra-base daylight bulb and shielded in front by a ground glass for diffusing the light and rendering the illumination of the transparencies quite pleasing. Because of the free opening of each lighting compartment from above, which allows for the exit of heat, the pictures are not heated to any marked extent; nor does the light from the unexposed lamps interfere with the viewing of the pictures. Each picture carrier has its respective flasher.

(d) While ordinary paper prints may be used in the machine, it is really intended for transparencies, which prove far more fascinating to the restless child. The advantages of transparencies may be summarized as follows:

First, transparencies allow for a greater range of luminosity, depending on the viewing distance selected as well as on the density of the transparency. The companion stereoscope permits a range of intensity from 0 to almost 100 foot candles—quite an advantage in cases of amblyopia. While this model, unlike the senior stereoscope, does not have a rheostat, a reduction of intensity may be readily effected by inserting a sheet of noninflammable frosted plastocel behind each picture.

Second, transparencies look more natural and lifelike.

For lighting opaque prints or pictures, illumination may be obtained by an accessory table lamp.

(e) The size of the picture holder, 6 by 6 cm., was selected to correspond to the most popular sized stereoscopic camera in use at the present time and to answer the requirements of the physician who may choose to make his own pictures.

(f) The septum is a unique departure in that it is rigid and immovable and extends the full range of the instrument, so as to insure independent use of each eye at any viewing distance.

(g) The connecting rod is clearly marked off in centimeters from 10 to 25 cm., respectively, although the viewing boxes may be brought still nearer, namely, to within 6 cm. of the lenses. This has been made possible through the incorporation of a simple space-saving viewing head which increases the range of accommodation possible.

(h) The viewing head consists of two rigid lens holders at an interlenticular separation of 80 mm., which permit the insertion of selective lenses. These lenses are of large diameter, so as to yield a wide angle effect, and are also adaptable to small interpupillary diameters. The frame has a pair of slots or compartments for receiving any additional lenses that may be desired. For example, a person with presbyopia who requires convergence exercises because his reading correction induces an annoying exophoria for near vision (convergence insufficiency) can hardly find inspection through the bifocal reading segments practical. A reading correction added to the viewing lenses (in the stereoscope) solves this difficulty. Prism holders incorporated in the viewing head allow for still greater ranges of elasticity.

(i) The companion stereoscope is unusually elastic in its range of operation. By reducing the strength of the viewing lenses, the instrument may be adapted to increasing accommodations. For example, with plus 2 D. spheres, more than 15 diopters of accommodation may be required at the proximal viewing distance of 5.5 cm. In the same way, the possible ranges of adduction and abduction allow for elasticity and control, depending on the viewing distance and the lenses selected in the viewer. In terms of diopters, a total range of 100 diopters or almost 50 degrees, would be possible at a viewing distance of 20 cm., and double this amplitude (in diopters) would be possible at a distance of 10 cm. By bringing the picture to the proximal limits (5.5 cm.), the amplitude may be further increased, not taking into consideration the added reserve amplitude which the prism carriers could provide.

As this instrument, much like its senior partner, is designed to measure not only the range of fusion but the exact amount of its individual components, abduction and adduction, the adjustable pointer operating with the calibrated millimeter scale offers a wide latitude for operation. For anomalies amenable to orthoptic training, such an elastic range is quite generous.

(j) The instrument lends itself to the drawing and copying of illustrations by the substitution of ordinary drawing paper in one of the carriers for one of the pictures. This is made possible by the height and angle at which the instrument is built.

The instruments described here were made by the Precise Instrument Company, of Brooklyn.

OPHTHALMOLOGIC SHORTHAND

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CHICAGO

The purpose of this paper is to stimulate interest in a standardized ophthalmologic shorthand for use in clinics.

Abbreviations are used by every clinician. Much could be said about the more common ones in use and also about local peculiarities and pet abbreviations. Difficulty in deciphering abbreviations causes a waste of time and energy. The difficulty becomes more pronounced when there is the complication of poor script. The results of this are frequently seen in the permanent records.

Two factors stand out clearly:

1. An accepted ophthalmologic shorthand would make clinical work easier by reducing the time and strain involved in reviewing reports and in recording histories and findings. It should also increase clinical efficiency in the more important work of examining and treating patients.

2. Stenographic efficiency would be greatly improved. Less time would be consumed in making permanent records.

An incomplete list of abbreviations is submitted for study. Many of these are already in common use. Obviously this list will require improvement.

For the development of this shorthand the following rule should be generally adopted: Single letters should be used whenever logical, but when two words beginning with the same letter are to be abbreviated, frequency and importance of use should determine which word will be abbreviated with a single letter and which will receive one or more additional letters, as

Vision	V.
Vitreous	Vit.

The names of certain structures of the eye, because of importance and frequency of use, should be treated as proper nouns and capitalized.

Cornea	C.	Disk	D.	Choroid	Ch.
Sclera	S.	Retina	R.	Pupil	P.
Lens	L.	Iris	I.	Fundus	F.
Conjunctiva	Co.	Vitreous	Vit.		

Whenever a compound word or a group of two or three words is used, the two or three letters could be united or a hyphen used to signify such an intention.

Corneoscleral	CS or C-S	Tear Sac	T-S
Left Eye	L-E	Anterior Chamber..	A-C
Right Eye	R-E	External Ocular Muscles	
Both Eyes	B-E	E-O-M	

Designations of important clinical findings that are frequently mentioned, names of special drugs and certain common terms should be capitalized.

Tactile Tension.....	T-T	Vision	V.
Red Reflex.....	R-R	Light	Lt.
Near Vision.....	N-V	Consensual	Cons.
Distant Vision.....	D-V	Accommodation	Acc.
		Convergence	Conv.
Homatropine	Hom.	Divergence	Div.
Atropine	Atr.	Lt.-Cons.-Acc. (united).	L-C-A
Main Complaint.....	M-C		

Many words might be treated as common nouns and not capitalized. In this list are the names of indefinite structures, such as "artery," "muscle" and "membrane"; the names of relatively unimportant structures, such as "puncta" and "cilia"; descriptive words or adjectives denoting direction, such as "superior," "upper" and "nasally"; other qualifying words; the terms "opacity" and "injection," and words regularly used in taking a history. Here, too, the rule for importance and frequency of use should determine the use of the single letter for the abbreviation.

For words in less frequent use, some logical abbreviation should be adopted that is easily remembered. Words used in the diagnosis should be capitalized and usually not abbreviated. Words treated as common nouns include the following:

artery	a.	canaliculi	can.	opacity	opac.
vein	v.	capsule	cap.	moderate	mod.
vessel	vl.	upper	up.	severe	sev.
nerve	n.	lower	lo.	lateral	lat.
muscle	m.	superior	sup.	nasal	nas.
cilia	c.	medial	med.	temporal	temp.
lid	l.	headache	h.a.	injection	inj.
puncta	p.	redness	rdn.		
membrane	mb.	tearing	trg.		

Certain suffixes, such as “-itis,” in the interest of lucidity probably should not be abbreviated but merely added to the original abbreviation.

Ch itis
R itis

On the other hand, other suffixes could logically be abbreviated.

Scopy py
Retinoscopy R-py

To indicate the plural of words, a hyphen and merely “s” could be added.

arteries a-s

Certain nomenclature will necessarily require interpretation in order to give a clear meaning to its abbreviation. Many ophthalmologists favor the use of “d.d.” in place of “p.d.” in giving the measurement of fundic lesions. This is sound logic, because the optic disk is usually easily defined while the papilla is relatively ill defined.

Disk diameter.... dd.
Vein width..... vw.

In using the latter abbreviation, one could specify that this should be judged from the vein sector, which extends the short distance from the margin of the disk to the border of the papilla. When the vein is pathologically dilated or contracted, the measurement “vw.” would signify the examiner’s estimation of the caliber of the vein when normal.

In considering the adoption of an ophthalmologic shorthand, one easily recognizes that a habit once established is broken with difficulty. Certainly, this will apply to many ophthalmologists who have been in practice for a long time.

It is to these leaders that one must look for acceptance or rejection of any change in the system of clinical records; at the same time, one feels confident that if such a change is merited, it will be made.

To be of any practical value, a clinical shorthand must have the stamp of official approval, in which case what must at first seem strange becomes an easily familiar and almost common language. The motivation for its adoption would be to simplify clinical reports, to reduce the drudgery of clinical routine and in general to establish an added factor for increased clinical efficiency.

PROGNOSIS OF BACILLUS WELCHII PANOPHTHALMITIS

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CHICAGO

Among the rare if not the rarest of deep infections of the eyeball is that caused by *Bacillus welchii*. This organism is also responsible for highly virulent and extremely grave infections in other parts of the body, which result in a fatal issue in a high percentage of cases. During the World War the mortality from such infections was extremely high, and even now in civil life the infection causes the surgeon much concern, even if the diagnosis is made early and intelligent care is administered.

There have been no deaths reported to date in cases of infection of the eye with *B. welchii*, even though enucleation has been done instead of evisceration. In such cases the clinical course is not severe, and complete recovery with negative cultures can be expected in two weeks after removal of the eye or its contents.

Twelve cases have been reported in the literature to date, five in Great Britain, four in France, one in Austria and two in the United States. James¹ made a clinical diagnosis of the infection on the basis of gas bubbles in the anterior chamber and eviscerated the globe. Heath² reported a case of panophthalmitis in which positive cultures were obtained and evisceration was performed. Ridley³ reported the development of gas gangrene and panophthalmitis within twenty-four hours after a penetrating wound of the eye. He eviscerated the eye. Hamilton⁴ reported two cases of *B. welchii* infection of the globe, with evisceration in each case. Chaillous⁵ reported two cases, and Darier,⁶ two. Enucleation was done in all four cases. Rieger⁷ reported a case characterized by cachexia in which the injury was due to a piece of steel in the eye. Evisceration and injections of milk brought about speedy

1. James, R. R.: *Ophth. Rev.* **29**:161, 1910.

2. Heath, W. E.: *Brit. J. Ophth.* **13**:576, 1929.

3. Ridley, F.: *Tr. Ophth. Soc. U. Kingdom* **49**:452, 1929.

4. Hamilton, J. B.: *Brit. J. Ophth.* **14**:452, 1930.

5. Chaillous: *Clin. opht.* **7**:265, 1904-1905.

6. Darier, A.: *Clin. opht.* **12**:227, 1906.

7. Rieger, H.: *Klin. Monatsbl. f. Augenh.* **96**:548, 1936.

recovery. Berry,⁸ of Brooklyn, had a patient who was hit in the right eye with a chip from a nut, and eighteen hours afterward active panophthalmitis developed. A roentgenogram showed a foreign body 2 by 4 mm. in size and located 20 mm. behind the anterior surface of the cornea, 4 mm. below the horizontal plane and 6 mm. nasally to the vertical plane. A gas bubble filled the whole anterior chamber. After the entrance of a knife into the scleral wound, blood-tinged fluid escaped around the shank of the knife. The next day the eye was enucleated, and cultures were positive for *B. welchii*.

In 1934 I⁹ reported a case of *B. welchii* panophthalmitis: An automobile mechanic was hit in the left eye while pounding on an axle shaft. He did not seek treatment for about twelve hours, and when seen by me he had an intensely inflamed eye, with beginning hypopyon. There was a small wound in the limbus, and what appeared to be a small bubble was seen in the anterior chamber. A roentgenogram showed a piece of steel 1 by 3 mm. in size and located 10 mm. back in the eye. An incision was made, which filled with a coffee-ground discharge. Severe panophthalmitis followed removal of the piece of steel, necessitating evisceration in twenty-two hours. Cultures were positive for *B. welchii*. After injections of *B. welchii* serum plus free drainage, the patient was able to leave the hospital in ten days, at which time cultures were negative.

On Sept. 29, 1937, a Negro came to my office stating that the same morning he was hit in the right eye by a stone while using a pick ax. He was sent at once to St. Luke's Hospital. Examination on the operating table disclosed a large perforating wound of the cornea, a traumatic cataract and some prolapse of the iris. A roentgenogram showed a stone in the vitreous; this was removed and a complete flap operation was done after the prolapsed iris was amputated. When the eye was dressed, after twenty-four hours, it was noted that some dark thin pus exuded at the junction of the flap and also what appeared to be fine bubbles arose on slight pressure. A laboratory report on the specimen from the operating room was positive for *B. welchii* plus *Streptococcus viridans*. The contents of the globe were eviscerated at once, and it was noted that complete destruction of the vitreous had taken place in forty hours. After receiving massive doses of *B. welchii* mixed serum, the patient left the hospital in ten days.

In both of my cases panophthalmitis developed in two days, and destruction of the vitreous was complete in that time. Moreover, in both coffee-ground pus was present and the diagnosis was made partly on the basis of the formation of gas bubbles.

8. Berry, E. M.: *Am. J. Ophth.* **15**:1022, 1932.

9. Walker, S.: *Bacillus Welchii Panophthalmitis*, *J. A. M. A.* **102**:1561 (May 12) 1934.

In Jordan's¹⁰ textbook on bacteriology it is stated that gas gangrene is nearly always due to mixed aerobes and anaerobes of several species. Cultures of *B. welchii* do not blacken brain and meat mediums normally, but the presence of metallic iron produces marked discoloration. This fact probably explains the coffee ground secretion which was noted by Dr. Berry in his case and also by me in both my cases.

I am impressed with the rarity of *B. welchii* in perforating and lacerated wounds of the eye. During the last fifteen years I have operated in over 500 cases of intra-ocular foreign body (steel) and in as many cases of penetrating or lacerated wound of the eye. From this large number of cases the present one is my second case of *B. welchii* panophthalmitis. Most of my patients are from industrial concerns and are therefore exposed to different types of infection. Why my colleagues in general industrial practice often have cases of *B. welchii* infection and I do not is a mystery to me. The mortality from such infections in other parts of the body is high, and yet in thirteen known cases of this infection following ocular injury there has been an uneventful recovery in every case. With the *venae vorticosae* and the deep ciliary vessels in close proximity, and exposure of the meninges through the optic nerve sheath possible, it is difficult to explain why there are no fatal cases. Possibly earlier diagnosis and removal of offending tissue may offer some explanation; yet these factors in themselves are not enough.

CONCLUSIONS

1. Intra-ocular foreign bodies of different types are potential carriers of *B. welchii*.
2. Early diagnosis is apparently of prime importance. The coffee-ground discharge from the wound and the formation of gas bubbles are nearly conclusive evidence, even without laboratory findings.
3. Panophthalmitis due to *B. welchii* apparently does not have the grave prognosis that *B. welchii* infection has in other parts of the body.

10. Jordan, E. O.: A Textbook of General Bacteriology, ed. 11, Philadelphia, W. B. Saunders Company, 1935.

Ophthalmologic Review

EDITED BY DR. FRANCIS HEED ADLER

THE CONCEPT OF ABNORMAL RETINAL CORRESPONDENCE

A THEORETICAL ANALYSIS

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CHICAGO

During the past three or four years the concept of abnormal retinal correspondence or abnormal projection has claimed more and more attention among workers in the field of orthoptic training, with the consequence that testing for abnormal retinal correspondence has become one of the most important procedures in the routine examination of patients with squint. Accordingly, if one is a squinter one of three outcomes seems possible: One may practice complete suppression of one eye; one may use either eye alternately, or abnormal retinal correspondence or abnormal projection may develop. Should one happen to belong to the group in which the last outcome has developed, a slow process of reeducation, which, according to some authorities, seems almost impossible, is necessary before it may be hoped to straighten the eyes by any orthoptic measure or even to keep them straight after an operative procedure. If this is so, what condition is found in a patient who has abnormal retinal correspondence or abnormal projection?

DEFINITION

A summary of some typical descriptions of abnormal retinal correspondence or abnormal projection found in the literature is as follows: If a patient has abnormal retinal correspondence or abnormal projection he uses the macula of one eye with a nonmacular area of the other eye; the sensation, however, is projected otherwise than as actually received by either eye. For example, a child with an angle of squint of 20 degrees may fuse two pictures in the synoptophore around zero or much nearer to zero than would be expected from his angle of squint. Because of this phenomenon and because the two maculae are apparently not used together, the child is reported as having abnormal retinal correspondence and abnormal projection. To be sure, the literature offers variations of this theory, and different authors have stressed various aspects of it,

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but all seem to be equally ambiguous in their use of the terminology and in the description of the actual findings. For example, Pugh¹ spoke mostly in terms of false projection and stated the belief that its mechanism is mainly cortical. However, she proceeded to attempt to find a retinal correlate in a "specialized hypersensitive zone lying between the macula and the false projection spot." According to this theory, normal projection can be regained only through a process of desensitizing such areas.

Mayou² called abnormal retinal correspondence and abnormal projection the objective and the subjective part of the same phenomenon. Yet in the discussion of the diagnosis and treatment of abnormal retinal correspondence she built her theory and method of treatment on purely anatomic grounds. She maintained that the angle of squint as measured objectively must coincide with the angle at which the patient fuses on the synoptophore. No cure may be expected until this condition is reached, and this may be accomplished by alternate stimulation of both maculae at the projection angle.

According to Travers,³ from 50 to 60 per cent of persons with convergent squint have abnormal retinal correspondence, and if his interpretation of his findings are correct many may be doomed to remain in that condition all their lives. His view is based on a theory of exact retinal point to point relationship, according to which the smallest deviation of the two retinas from such a relationship would cause serious abnormalities. Whether or not normal retinal correspondence may be regained once abnormal retinal correspondence has developed seems to depend on various factors, the two most important being the age or duration of the defect and the size of the deviation. Travers stated the belief that normal retinal correspondence can be obtained more easily in cases of a high degree of concomitant strabismus than in cases in which there is only a small degree of squint, in which instances it seems almost impossible to repair the damage done. He even said that in cases of squint with an angle of 10 degrees and lower it is impossible to reestablish normal retinal correspondence. His is the most extreme view and apparently embodies a generalization of all the other views. He makes the problem an anatomicoretinal one, and on reading his work one may almost become convinced that abnormal retinal correspondence lies at the bottom of all failure of orthoptic as well as surgical treatment.

1. Pugh, M. A.: A Classification of Cases of Concomitant Strabismus, Based on Etiological Factors, *Brit. J. Ophth.* **18**:446-451, 1934.

2. Mayou, S.: Principles of Orthoptic Training, *Brit. J. Ophth.* **20**:360-374, 1936.

3. Travers, T. B.: Comparison Between Visual Results Obtained by Various Methods Employed for the Treatment of Concomitant Squint, London, George Pulman & Sons, Ltd., 1936.

None of the aforementioned writers, who represent the more recent advocates of the concept, have given any clear explanation of the anatomic function of abnormal retinal correspondence. They all seem to assume that because they found that in certain squinters the two retinas do not function in accordance with the established theories of the correspondence of retinal points their findings must be due to an abnormality in retinal correspondence. The theory of abnormal retinal correspondence has been developed from the basic hypothesis that exact retinal correspondence is an objectively demonstrable and invariable fact, and, of course, it will stand or fall in accordance with the degree of the validity of this basic hypothesis.

To a careful reader it should appear by now that this theory embodies some grave inconsistencies. Why are two terms, abnormal retinal correspondence and abnormal projection, used? Are these merely two different names for one thing, or are they two concepts for two distinct phenomena? If so, why are the terms employed interchangeably? What is the meaning of these concepts? What assumptions do they imply, and do the facts agree with these assumptions? Is one justified in assuming that because the two retinas do usually manifest some degree of correspondence any apparent deviation from this rule must be due to abnormality? Can normal retinal correspondence and abnormal correspondence be demonstrated objectively? Is the theory of abnormal retinal correspondence and abnormal projection based on objectively demonstrable facts or on subjective inferences? These are some of the questions which may arise, and it is the purpose of this paper to clear up, if possible, a few of them.

ANALYSIS OF THE CONCEPT IN THE LIGHT OF EXISTING NEUROLOGIC FINDINGS

I shall first analyze the concept of abnormal retinal correspondence to see whether the underlying facts on which this theory has been developed are in harmony with the clinical findings. What are the postulates on which this theory rests? The concept of abnormal retinal correspondence depends primarily on making the fovea a point of reference in relation to which the two retinal images must lie on corresponding points. This means that if the two eyes are apparently in such a position that the images fall on the two maculae so that there is a point to point relationship between the cones of the two foveae and the macular areas the two images will be fused into one composite image, because for every nerve ending on one retina there is a corresponding nerve ending on the other retina, which carries its impulses to the same brain cell. These cells are supposed to be distributed on and from the fovea in symmetrical relationship, so that a given nerve ending at a given point on the fovea or a given point on a nerve fiber

from the fovea has its corresponding nerve cell on exactly the same point in the other retina. But a certain degree of inaccuracy had long been observed, and therefore the theory had been changed to an area to area correspondence, the two areas overlapping in some yet unknown manner on their way to the final brain centers. This being the theory, I shall examine whether the necessary facts to substantiate it exist. Is it possible in any way to demonstrate that the nerve fibers from corresponding retinal areas converge either to a final common path or to a common area in the visual brain center or to show whether the nerve endings on the same area of both retinas terminate in one and the same nerve cell in the brain?

Cushing⁴ and Horrax and Putnam⁵ have presented some clinical evidence from studies of the effects on the visual fields of lesions of the temporal lobe and of a brain tumor in the occipital lobe. This material seems to point to the fact that corresponding retinal points are not represented in the same parts of the optic radiations. If a tumor of the temporal lobe involving parts of the radiation may produce scotomas differing markedly in form in the two eyes, such exact retinal or cortical correspondence as was assumed would certainly not be possible.

Minkowski⁶ in a study of monkeys observed degeneration in alternate zones of the lateral geniculate nucleus after enucleation of one eye. His observations indicate that fibers from corresponding points of the two eyes do not reach a final common path up to that zone. He also noted that each retinal point is projected to a relatively large cortical area and that the cortical fields for adjacent retinal points overlap. According to these observations, anatomic evidence for fineness of difference in retinal projection seems to be lacking. There appears to be a good bit of overlapping of separate retinal areas.

However, Lashley⁷ recently published two studies on the projection of the retina on the primary optic centers, which furnish considerable evidence in favor of retinal correspondence and correspondence of cortical areas but at the same time allow or account for the apparent absence of cortical correspondence noted by previous investigators. In

4. Cushing, H.: The Field Defects Produced by Temporal Lobe Lesions, *Brain* **44**:341-396, 1921.

5. Horrax, G., and Putnam, T. J.: Distortions of the Visual Fields in Cases of Brain Tumor, *Brain* **55**:499-523, 1932.

6. Minkowski, M.: Ueber den Verlauf, die Endigung und die zentrale Representation von gekreuzten und ungekreuzten Sehnervenfasern bei einigen Säugetieren und beim Menschen, *Schweiz. Arch. f. Neurol. u. Psychiat.* **6**:201-252, 1920; **7**:268-303, 1920.

7. Lashley, K. S.: (a) The Mechanism of Vision: VII. The Projection of the Retina upon the Primary Optic Centers of the Rat, *J. Comp. Neurol.* **59**:341-373, 1934; (b) The Mechanism of Vision: III. The Projection of the Retina upon the Cerebral Cortex of the Rat, *ibid.* **60**:570-576, 1934.

these studies small cortical lesions were followed up to the geniculate body within the geniculate nucleus. In the first of these studies^{7a} Lashley reported his observation that the optic fibers have no orderly arrangement in the chiasm and optic tract. They intermingle and cross each other freely but finally resume their original relative position, although now inverted and projected in a third dimension in the lateral geniculate nucleus. Within the optic radiation the projection fibers are again complexly crossed, but again they emerge in the cortex after another inversion to reproduce the topographic arrangement of the retina. In the second of his studies^{7b} he has given a fairly detailed picture of the cerebral cortex of the rat, and the results clearly indicate that these areas are limited and do not overlap much. He stated:

The most anteromesial part of the area striata represents the dorsal median of the eye. Along the lateral margin of the area successive sections of the temporal quadrants are represented, and the projection of the nasal quadrants continues along the mesial border. Consecutive zones in the retina seem to be represented by consecutive zones in the area striata. The binocular field is projected to the anterolateral margin of the area.

From these observations Lashley concluded that in the rat there seems to be true cortical representation of retinal areas, with maintenance of a general topographic relation, but that in addition there are considerable plasticity, equipotentiality and mass action. This double observation may explain the apparently contradictory results obtained by different investigators. There seem to be two distinct types of organization which influence and determine visual integration, the one being plastic, equipotential and able to function in a fairly general way and the other having in the cortex a pattern of excitation corresponding in its spatial projection to the spatial pattern of excitation on the retina. These two types of integration have a certain dynamic relationship and seem to be equally important for the integration of the visual experience.

The problem of obtaining neurologic information on the correspondence of the two ocular images is therefore not simple. Perhaps that is why the nature of retinal correspondence is so little understood and has remained on a purely theoretical basis since the time of its formulation by such eminent physiologists as Mueller, Hering and Helmholtz. The importance of retinal correspondence and disparity in relation to fusion and as criteria of depth has long been recognized. Although retinal correspondence seems to be important for fusion, retinal disparity seems to be equally important for depth perception. These two factors have to work hand in hand in order that a person may obtain maximal efficiency in the perception of space.

Many investigators attempted to gain insight into the nature of retinal correspondence through a study of depth perception. Depth, it is assumed, is determined by small degrees of retinal disparity, and the

disparity may be measured in terms of the degree of failure of identical points to be imaged on corresponding points. If the disparity remains within a certain limit, depth is experienced. If it exceeds that limit, diplopia results. This, however, is seldom noticed in ordinary life unless the disparity cannot be overcome by a good "fusion impulse." The most widely accepted theory of depth is thus built on the assumption that a certain amount of disparity exists, and it stresses the importance of disparity rather than that of correspondence.

Another method by which retinal correspondence is frequently studied is with the horopter, the theory of which is undoubtedly known to any student of physiologic optics and therefore needs no mention other than calling to mind that the work of Müller, Helmholtz and Hastings belongs among the classic investigations made with the horopter. In addition to these classic studies, some recent investigations with the horopter have been reported which merit specific mention in this connection, because the investigators, Ames, Ogle and Gliddon⁸ stated the belief that their concept of the horopter differs markedly from the classic one and that their horopter furnishes a more adequate and scientific means for studying retinal correspondence. These authors determined the horopter on the hypothesis that "any particular pair of corresponding retinal points by innervating a single brain center gives the subjective sensation of a particular directional value. Moreover, this directional value is the same whether that brain center is innervated by both of the corresponding points or by either alone. Therefore it follows that a relation must exist between the optical projections of retinal elements of each eye and directional values and that these two relations of each eye must correlate through the horopter." Thus, if the projection point and the subjectively projected horopter coincide, the images of the fixation point fall on corresponding retinal cells; but if the true longitudinal point is displaced, this indicates that the images of the point of fixation fall on noncorresponding retinal points.

This definition of the horopter has one advantage over the older ones. It admits that determination of the horopter is based on subjective inferential data without assuming that these data express an exact anatomic retinal correlate. These authors correctly recognized that exact anatomic correspondence cannot be obtained. However, they replaced that assumption with a hypothesis which presents additional difficulties. According to their view, a subject's localization represents a definite response to a specific cortical direction value, this direction value being a sensation due to cortical innervation of a pair of corresponding retinal points. This hypothesis has no more possibility for objective verification than has the other one.

8. Ames, A.; Ogle, K. N., and Gliddon, G. H.: The Horopter and Corresponding Retinal Points, *J. Optic Soc. America* **22**:575-631, 1932.

In order that the complexity of the problem of determining the nature of retinal correspondence may be fully understood I shall recapitulate the hypothesis which by logical necessity must underlie such a study and discuss the probability of an experimental verification of this hypothesis. The theory of the horopter demands two major assumptions: The first is that if the two retinas are brought into superposition the two areas will have pairs of points which coincide. The second is that if the lines of regard pass through the retinal centers they will meet at the objective point which is fixated; that is, if the projected, or subjective, visual object coincides with the fixated object its images are seen as one, and the retinal points coincide, but if the objective and the subjective visual object do not coincide, diplopia is experienced.

The first of these assumptions can probably never be tested. Before one could know the exact correspondence between the two retinas and the cortical areas one would have to know the exact points of intersection of the projection paths and the exact position of the two retinas. The position of the two retinas could hardly be tested, since, according to the findings of Park,⁹ it does not remain stationary. The two eyes have an ever varying angle between the visual axis and the optic axis, and in addition they retract and protrude in their sockets, even during apparent complete fixation.¹⁰ Furthermore, there exist also varying intrinsic movements of the extra-ocular muscles, even though the eyes are steadily fixating on a given spot. Such findings would necessitate an explanation of retinal correspondence based on some dynamic concept rather than depending on a static cell to cell relationship. Although the exact anatomic correspondence of retinal points has no direct observable basis in fact, the subjective, or projected, visual object has repeatedly been used as the criterion of measurement of retinal correspondence by assuming that if a given subject reports any two projected visual objects from the two eyes as coinciding at the fixation point the two retinal points correspond. If, on the other hand, diplopia is reported, it has been assumed that the two images fall on noncorresponding points. That a subject's report cannot be thus relied on Lau¹¹ pointed out in a paper dealing with binocular depth localization. He found a disparity between the position of the fovea and the projected image and said: "It appears from this that in normal life we probably always

9. Park, G. E.: An Investigation of the Angular Relation of the Visual (Visierlinie) and Optic (Corneal) Axes of the Eye, *Am. J. Ophth.* **19**:967-974, 1936.

10. Park, R. S., and Park, G. E.: The Center of Ocular Rotation in the Horizontal Plane, *Am. J. Physiol.* **104**:545-552, 1933.

11. Lau, E.: Binocular Depth Localization, *Ztschr. f. Sinnesphysiol.* **53**:1-35, 1931.

assume an eye position which deviates from the mathematical convergence." This raises the problem of projection, which will be taken up more fully at a later point in this report.

So far it has been found that the clinical and neurologic evidence furnishes little definite proof as to the exact nature of retinal correspondence. It may merely be stated that some neurologic findings point toward a certain correspondence between retinal and cortical areas but that at the same time considerable equipotentiality and mass action exist. At present no reliable objective method for measuring retinal correspondence is known, and the subject's report of his projected visual experience fails to be very reliable as a criterion of measurement. It is doubtful whether a subject's report of his projected visual object represents an exact replica of his retinal and cortical pattern of the visual object. Since it is almost impossible to obtain an objective measure of normal retinal correspondence, it would be justifiable to assume that measuring abnormal retinal correspondence would be still more difficult. At any rate, any existing disparity between the two retinas of a pair of squinting eyes should be considered in the light of all the knowledge about the nature of retinal correspondence, and such a procedure would probably disclose that the correspondence of the two retinas, whether in normal eyes or in squinting eyes, is exceedingly fluctuating but at the same time follows similar tendencies.

SOME EXPERIMENTAL EVIDENCE

A comparative study which is at present being carried on at the department of ophthalmology of the Northwestern University Medical School gives some evidence indicating that no person, whether he has normal eyes, phoria or squint, fuses on the synoptophore at exactly zero of arc or at exactly the degree of his phoria or the angle of squint.

So far, I have carried out studies on three groups of patients consisting of forty persons without muscular imbalance, forty with either esophoria or exophoria and forty with either esotropia or exotropia. None of these subjects had any pathologic changes of the fundi, and in cases of refractive error all the tests were made with the subject's correction. All these subjects were tested for phoria by means of the screen test and the parallax test, and in cases of strabismus the manifest deviation was measured with the perimeter. For each person four or five measures of retinal correspondence or noncorrespondence were made, with either the amblyoscope or the synoptophore. The subject was allowed to make his own adjustments of the synoptophore for superimposing the two pictures. The results of these subjective tests were then compared with those of the screen test and the parallax test or with those of the perimeter test.

Theoretically, exact correspondence would exist when the measures of the retinal correspondence and the size of the phoria or the degree of squint exactly coincide. According to this definition, any deviation from these measures would indicate abnormal retinal correspondence. The variability or deviation between the degrees at which a person superimposes on the synoptophore or amblyoscope and his measure of the phoria or the degree of squint may be considered a criterion of retinal correspondence and the size of this deviation a measure of retinal non-correspondence. Each subject received four or five trials with the synoptophore or amblyoscope, in that way giving several measures of retinal correspondence or deviation from retinal correspondence. The largest and the smallest deviation were then tabulated. The average of all these deviations for the three groups of subjects are reported in tables 1 and 2. Thus the results shown are averages for the group.

TABLE 1.—*Average of Horizontal Deviation from Zero in Subjects with Normal Eyes and in Those with Phorias and from the Degree of Squint in Subjects with Strabismus*

Type of Subject	Largest Average Deviation, Degrees	Probable Error of Largest Average Deviation	Smallest Average Deviation, Degrees	Probable Error of Smallest Average Deviation
Normal.....	3.00	± 0.21	1.21	± 0.15
With phoria.....	6.05	± 0.41	3.70	± 0.34
With squint.....	6.85	± 0.59	4.21	± 0.55

Table 1 gives the average of the largest and the smallest horizontal deviation from zero for persons with normal eyes and persons with phoria and from the degree of squint for persons with strabismus. It may be noticed that none of these groups showed exact retinal correspondence. There is considerable variation in the measures of actual superposition on the synoptophore or amblyoscope and that of the phoria or the squint, or of the zero point in cases of normal eyes. This deviation varies from time to time and from person to person, but, considering the subjects as a group, the variability is about the same for persons with squint and those with phoria, while it is somewhat less for persons with normal eyes.

The degree of variability in retinal correspondence not only seems to vary according to the type of the patient—a patient with normal eyes, one with phoria, or one with squint—but it is influenced also by the method of measurement. For example, when the synoptophore was used to measure retinal correspondence in cases of squint, the largest and smallest average deviations were greater than the measures obtained with the amblyoscope. For the synoptophore the largest average deviation was 7.70 degrees, and the smallest 5.60 degrees, while with the amblyoscope the two measures were 5.00 and 2.85 degrees, respectively.

Again, the averages changed if the objective measures, or those determined with the perimeter, were first corrected for the angle gamma before being compared with the measures made with the synoptophore, or the measures of retinal correspondence. This procedure resulted in still smaller averages for the group.

Still another comparison was made, the results of which are given in table 2. As is seen from table 1, the average variability of retinal correspondence in the cases of phoria is 6.05 degrees and 3.70 degrees for the largest and the smallest deviations, respectively, if the deviations are measured from zero. But if the degree of the phorias is taken as the base, the averages for the group are only 3.30 and 2.35, which are practically the same as those for the group of normal subjects. In table 2 the largest and the smallest average deviation from zero for the group of persons without muscular imbalance are compared with the same average deviations for persons with phoria if these deviations were computed from the angle of the phoria instead of from zero. Thus

TABLE 2.—*Average of Deviation from Zero in Subjects with Normal Eyes and from the Angle of Phoria in Subjects with Phorias*

Type of Subject	Largest Average Deviation, Degrees	Probable Error of Largest Average Deviation	Smallest Average Deviation, Degrees	Probable Error of Smallest Average Deviation
Normal.....	3.00	± 0.21	1.21	± 0.15
With phoria.....	3.30	± 0.37	2.35	± 0.42

considered, the variability from perfect retinal correspondence becomes the same for each group. This indicates that whether or not the findings show normal or abnormal retinal correspondence may depend largely also on the way of treating the data.

Therefore it may be said, in a general way, on the basis of these findings, that no person, whether he has normal eyes, phoria or squint, fuses on the synoptophore or the amblyoscope at exactly zero of arc, the angle of squint or the degree of his phoria. There is considerable variability from person to person, as well as from time to time for a given person. Furthermore, the degree of the discrepancies, if such are present, varies according to various factors, such as the method of measuring the deviation, the method of measuring retinal correspondence, the method of treating the data and probably still other as yet unknown factors. No evidence of any very large discrepancies has been found so far, except in a few instances in which the patient had a false macula. This term is understood to describe the condition in cases of monocular squint associated with amblyopia in which the amblyopic eye fixes at the angle of squint even when the normally fixing eye is covered. At present, our data obtained for patients with strabismus, those with

phoria and those with normal eyes indicate that the abnormality of retinal correspondence found in cases of strabismus is little different from a certain variability also found in persons with normal eyes. This instability is probably due to some action of the movements of the ciliary muscles and extra-ocular muscles the purpose of which is to maintain and establish clear and single vision by focusing the central image on the two foveae.

Although this interpretation of abnormality in retinal correspondence differs considerably from that of other investigators, it is not without experimental support. McAllister,¹² Gertz,¹³ and Grim¹⁴ all reported definite movements of each eye when fixation was apparently stationary. Both Grim and Gertz found excursions of from 4 to 10 degrees when the eyes were fixed, while Park⁹ reported excursions as high as 17 degrees. They vary from person to person and from condition to condition. They seem to increase with the length of fixation and fatigue and may be altered in nature by administering physostigmine salicylate or atropine sulfate. They may be present as gradual sliding movements or quick and jerky excursions. Park stated the belief that in binocular foveal fixation the physiologic function cannot be steady and constant, since the organism is constantly adapting itself to ever varying neuromuscular-glandular conditions. Only the resultant, the fact that the two foveae are kept steady under the central image, will remain constant.

Evidently the entire idea of retinal correspondence has been taken too literally. It seems that images may well be fused at unequal distances or even at opposite sides of the fovea. Peckham¹⁵ found this to be true in a study in which he made some intricate measurements of the location of the images in relation to the fovea. He noticed that in many cases of normal vision objects are not fused by means of the anatomic corresponding points, that frequently the two foveae are not under the two retinal images. Sometimes there were differences of 4 or 5 degrees, and yet the subject reported single binocular vision. By placing prisms base out or base in before the subject's eyes the author was able to bring the subjects to the point where diplopia should occur, while the latter still reported single vision. Furthermore, the eyes of the subjects in overcoming a 10 degree prism, moved through angles sometimes less than half this amount, while at others they moved even

12. McAllister: The Fixation of Point in the Visual Fields, *Psychol. Rev.* (supp.) **7**:17, 1905.

13. Gertz, H.: Ueber die Blick-Aberration und ihre Beziehung zur Netzhaut Correspondenz, *Acta ophth.* **13**:192-223, 1935.

14. Grim, C.: Ueber die Genauigkeit der Wahrnehmung und Ausführung von Augenbewegungen, *Ztschr. f. Psychol. u. Physiol. d. Sinnesorg.* **45**:9, 1910.

15. Peckham, R. H.: Foveal Projection During Ductions, *Arch. Ophth.* **12**: 562-566 (Oct.) 1934.

too far to bring the foveae beneath the image. Bielschowsky¹⁶ in a recent discussion of the etiology of squint reported some observations about retinal correspondence which would indicate considerable fluctuation and dynamic variability. He found that a patient may sometimes show abnormal correspondence while at other times he has normal correspondence, and that this condition is very unstable and may change either spontaneously or in the course of time.

A NEW HYPOTHESIS

If this is so, one may question the right to explain fusion as well as projection in terms of a static anatomic neural function. Whatever the retinal correspondence between the two eyes may be, whether the existing symmetry is geometrically exact, relative and fluctuating, it would be far better to consider fusion and projection as perceptual processes. Fusion would be the cortical interpretation of double images into a single experience, and projection the subjective interpretation of the visual system's constant adaptations to ever varying and complex stimulating conditions. Fusion, according to this definition would have a cortical basis and would be mostly learned. Helmholtz¹⁷ questioned the theory of specificity of nerve function and stated the belief that fusion is a perceptual affair arising from cortical integration at the point to which consciousness is adjunct.

A tiny infant has no projection. His visual objects are not located out in space. Only gradually through manipulating his visual objects do they become associated with his tactual, kinesthetic and auditory experiences and are then given attributes of space. One's knowledge of physical objects is dependent on the composite results of various coordinated sensory experiences. The location of the visual object is inferred from one's localizing movements and auditory and tactual sensations, the experience of parallax, one's knowledge of overlapping objects, the atmospheric conditions and other factors which contribute to knowledge of space. One naturally assumes that all the different sensory objects have the same location. Thus one learns to see things where one hears them and to hear them where one sees them, and one sees them in the place where one's hands can touch them.

As has already been mentioned in an earlier part of the paper, the assumption that the visual object must be located in the same position as its retinal image is without justification. For further clarification, let the case of ordinary visual sensation be considered. Its existence

16. Bielschowsky, A.: The Etiology of Squint, *Am. J. Ophth.* **20**:478-489, 1937.

17. Helmholtz, H.: *Treatise on Physiological Optics*, translated from German edition and edited by James P. Southall, Rochester, N. Y., The Optical Society of America, 1925, vol. 2.

and nature are functions of the external object that reflects the light into the eye. Its quality is dependent on the intensity of the light and the nature of the light waves. It is also dependent on cortical and retinal activities and the refraction by the lens through which the light is transmitted plus certain changes of the position of the eyes in their sockets due to retracting and advancing movements. Thus the visual object is dependent on a long series of events which are bound to modify the exact shape and position of the object. Furthermore, one localizes a visual object as right side up, while it is well known that the refractive surfaces of the eye give an inverted retinal image of all external objects. It has also been shown by Stratton¹⁸ that the wearing of a pair of lenses which rotates the retinal image 180 degrees does not materially affect the visual experience. Although these lenses inverted the visual world in respect to the tactual and conceptual standards, a new system of habits of manipulation was soon established which brought about a readjustment of the visual standards, and after a few days of practice the world once more became right side up. Thus one's interpretation of one's visual experience is not at all fixed by the actual sensory organization. In regard to position and shape, one's visual object is not a projected replica of one's retinal image but a perceptual and interpretative phenomenon.

The process of the retinal correspondence of the two eyes may be explained in a similar fashion. At birth the correspondence between the two retinas is very poorly developed. By watching an infant's eyes little coordination of the two eyes can be observed.

The learning of ocular coordination differs little from that of any other function of coordination, such as walking and swimming. At first the child exercises his muscles by trial and error, and the result of these random movements is clear, single vision. Gradually he learns to repeat these movements, which at first more or less accidentally brought clear and single vision, until gradually he learns to associate a certain muscular pattern with clear and single vision.

This initial clumsiness in a child's ocular coordination is easily understandable if one considers the fact that most children are born somewhat hyperopic, owing to axial development of the eye. At any rate, this condition brings about the necessity for an ever changing adjustment of the neuromuscular integration. Furthermore, one frequently finds that in infants the internal rectus muscles are hypertonic. All these conditions must influence the process of coordination and complicate the adaptive function, so that it is not surprising that the development of coordination is a gradual process which requires considerable learn-

18. Stratton, G.: Upright Vision and the Retinal Image, *Psychol. Rev.* 4: 182-187, 341-360 and 463-481, 1897.

ing. Thus, through the process of repeated reciprocal innervation and inhibition of the tonus in the opposing muscles, which is partly an innate and partly a learned function, the organism produces a tendency of the visual fields to unite, and the child learns to fuse the separate retinal fields.

Through association of movements of convergence and the innervation of the ciliary muscles, which are purely proprioceptive processes, the child is building up the "accommodative convergence association." But at this state he still has no fusion. So far his visual behavior is mainly a proprioceptive space direction affair, with poor coordination, resulting either in overconvergence or overinnervation of this ciliary muscles, or vice versa. This consequently causes diplopia and blurred vision, which sooner or later the child recognizes. Whenever this happens the child learns it from his association with touch. He discovers that when his eyes tell him that there are two objects his hands tell him that there is only one. This stage is probably reached about the time when he is getting old enough for the need of more accurate and clearer vision. Now a higher integration comes into play. Through voluntary attention he learns to control indirectly his internal rectus muscles, and also to control indirectly his ciliary muscles, because of their associated function with convergence.

This process may be described in mechanistic or subjective terms. In mechanistic terms the description is as follows: Whenever the two retinas are stimulated by light the equilibrium of the existing photo-chemiconeuromuscular integration becomes upset. As a consequence a new process of integration comes into play in order to reestablish equilibrium. This integrative behavior is in the nature of a proprioceptive convergence-accommodation adjustment, plus the cortical or associative direction process. In subjective terms, one would say that the subject adjusts his eyes by means of directing attention until clear and single vision is obtained, or until he fuses. This fusion becomes the subject's interpretation or perception of a specific image and response pattern of his visual apparatus.

By means of manipulating an object, by the process of coordinated movements of the extra-ocular muscles and by the constant shifting of the adjustment of the intra-ocular and ciliary muscles the subject gathers valuable clues for his interpretation of the location of visual objects. He learns that if his eyes are in a certain position and the image is on a certain part of the retina, the object lies straight ahead, to the right or to the left, up or down.

Should something suddenly happen to upset this neuromuscular balance, the person would at first continue with the same movements for projection or localization, which are the only ones which he knows how to use. But now, since drastically new conditions have arisen, his

interpretative responses no longer bring the habitual results. He experiences diplopia, with the consequence that his visual world disagrees with his tactual and auditory one. Since the human organism is an adjusting one, it immediately starts to develop a new object space pattern based on sensory experience. In other words, the person learns to adjust the new clues to the standards of his other modalities. He knows from his experience of touch or sound where an object should be, and to that knowledge he fits the ocular clues, by suppressing one eye, by using either eye alternately or by what some investigators have called false projection.

To call this new localization false projection is unjustifiable, since from the subject's perceptual standard this projection is as correct as his earlier one. It is false only from the observer's point of view, who assumes that the retinal image and projected experience must coincide. That such an assumption is false the results of experiments of Gertz, Peckham and Stratton give ample proof. The projection or interpretation of the visual experience is not bound by the exact sensory phenomena. Perception and judgment are complex behavior patterns of which the sensory elements are only one aspect. Perceptual activity is influenced by past experience and not only by a specific sensation received at a particular moment, and therefore the resulting behavior, whether it be in the form of a verbal statement or in the form of a localizing response, would necessarily embody a broader and more complex neuromuscular pattern than would be the case if it were only a direct response to a simple sensation. Accordingly, one cannot assume that the localizing into space of a visual object is an exact projection of the two retinal images of that object.

In the same way one can explain why sometimes after an operation for squint the patient localizes or fuses two images at the angle of his squint, although his eyes are now straight. This condition of *horror fusionis* usually soon disappears, which is added evidence that the organism quickly learns new localizing responses.

CONCLUSIONS

I shall now return to the problem of abnormal retinal correspondence and projection. As was shown in the course of this paper, it is difficult to study the nature of abnormal retinal correspondence, because so little is definitely known about normal retinal correspondence. The classic assumption that the two retinas correspond exactly by either a cell to cell or a retinal to cortical area relationship has no neurologic proof so far beyond the discovery of a certain topographic arrangement of the retinas in the cortical centers. Furthermore, various results of studies of fusion and projection carried out on subjects with emmetropic eyes

and without muscular imbalance have shown much more disparity between any given images on the two retinas than could possibly be present were there a geometrically exact correspondence of the two retinas. The accumulated body of facts points toward a dynamic plasticity rather than toward a static anatomic relationship.

It has also been questioned whether in investigations of abnormal retinal correspondence in which the physician questions his patient about the nature of the visual projected images one may assume that the patient's report exactly represents the image patterns on his retinas. The fact that fusion and projection are perceptual and judgmental behavior, which are influenced by past experience and experience from other sense modalities, suggests that a patient's verbal or localizing report of projected images cannot be considered a reliable criterion for measuring retinal correspondence or the degree of abnormal retinal correspondence. It must be remembered that a patient's localizing of his images is a perceptual interpretation of his visual experience, his conditioning by past experiences, and his knowledge of the object from touch and audition, as well as from the clues of his ocular convergence-accommodation adjustments.

The concept of retinal correspondence has probably been taken far too literally. Since analysis of the actual facts indicates considerable plasticity of retinal correspondence in normal eyes, it may well be assumed that those discrepancies in retinal correspondence found in certain cases of squint are of a similar nature and should therefore be explainable by the same hypothesis. Such a dynamic and functional approach to abnormal retinal correspondence in cases of concomitant strabismus would probably change the problem from one of abnormality to one of variability of the normal.

Drs. Sanford R. Gifford, G. E. Park and G. Guibor gave opinions, observations and helpful suggestions in this study.

News and Notes

EDITED BY W. L. BENEDICT

SOCIETY NEWS

Scientific Meeting, Eye Section, Philadelphia County Medical Society.—At the meeting of the Eye Section of the Philadelphia County Medical Society held at the Philadelphia County Medical Society Building, Feb. 3, 1938, Dr. Louis R. Wolf reported on clinical cases from the Temple University Hospital. The following papers were read: "Visualizing the Pathogenesis of Senile Cataract," by Dr. Aaron Brov; "Anatomy and Functions of the Orbital Fascia," by Dr. Charles W. LeFever, and "Differentiating the Various Types of Blurred Disks," by Dr. Glen G. Gibson.

At the meeting held on March 3, 1938, at the Philadelphia County Medical Society Building, Dr. Irvin Levy reported on clinical cases from the Will's Hospital. Dr. William Zentmayer discussed "Etiology and Diagnosis of Intraocular Tumors;" Dr. Alexander Fewell, "Prognosis and Treatment of Intra-ocular Tumors," and Dr. Edgar W. Spackman, "Ocular Roentgenologic Diagnosis."

Montana Academy of Ophthalmology and Oto-Laryngology.—The semiannual meeting of the Montana Academy of Ophthalmology and Oto-Laryngology was held in Butte, February 13 and 14. Dr. Roy Grigg, of Bozeman, was elected president for the ensuing year, and Dr. Ashley Morse, of Butte, was elected secretary-treasurer.

Royal College of Physicians and Surgeons of Canada.—At a recent meeting of the Royal College of Physicians and Surgeons of Canada it was decided to establish boards for certification in a number of specialties, including ophthalmology. A committee composed of Dr. S. Hanford McKee, of Montreal, chairman, with Dr. W. H. Lowry, of Toronto, and Dr. Septimus Thompson, of London, Ontario, was appointed to draft recommendations for future consideration.

Dallas Southern Clinical Society.—The tenth annual spring clinical conference of the Dallas Southern Clinical Society was held in Dallas, March 14 to 17, 1938. The headquarters were at the Hotel Adolphus. Lectures in ophthalmology were given by Dr. Conrad Berens, of New York.

Philadelphia County Medical Society.—At the meeting of the Eye Section of the Philadelphia County Medical Society on Feb. 3, 1938, the following program was presented:

"Clinical Cases from Temple University Hospital," by Dr. Louis R. Wolf; commentator, Dr. Walter I. Lillie.

"Visualizing the Pathogenesis of Senile Cataract," by Dr. Aaron Brav; commentator, Dr. Leighton F. Appleman.

"Anatomy and Functions of the Orbital Fascia," by Dr. Charles W. LeFever.

"Differentiating the Various Types of Blurred Optic Disks," by Dr. Glenn G. Gibson, with a lantern demonstration.

Before the program a postgraduate conference in ophthalmology was held by Drs. L. C. Peter, A. G. Fewell and I. S. Tassman.

New York Eye and Ear Infirmary.—The annual postgraduate week of the School of Ophthalmology and Oto-Laryngology of the New York Eye and Ear Infirmary will be held March 28 to April 2, 1938. Courses will be given in ophthalmology, otology, rhinology, laryngology, bronchoscopy and esophagoscopy. During the course, daily luncheons will be held, at which speakers of the day will preside. The annual dinner will be held Friday evening, April 1, at 7:30, Dr. Clyde E. McDannald presiding. Daily demonstrations will be held in the various clinics and in the special departments of the institution.

The fee for the entire course will be \$50. Application for registration should be mailed to the School of Ophthalmology and Oto-Laryngology, New York Eye and Ear Infirmary, Thirteenth Street and Second Avenue, New York.

Chicago Ophthalmological Society.—At the annual meeting of the Chicago Ophthalmological Society the following officers were elected for the year 1938-1939: president, Dr. Georgiana Dvorak-Theobald; vice president, Dr. Leo L. Mayer, and councilor, Dr. E. G. Nadeau. Dr. Earle B. Fowler was reelected secretary-treasurer.

Dr. C. S. O'Brien, of Iowa City, assisted by Dr. James Allen, read a paper entitled "Staphylococcus Conjunctivitis."

Eye Health Committee.—Plans for a study of problems pertaining to the health of the eyes of college students are being made by the Eye Health Committee of the American Student Health Association, with the aid of an Advisory Committee from the American Academy of Ophthalmology. The project will have the cooperation of the National Society for the Prevention of Blindness.

Dr. R. W. Bradshaw, of Oberlin College, Oberlin, Ohio, is chairman of the Eye Health Committee of the American Student Health Association; Dr. W. L. Benedict, of Rochester, Minn., is chairman of the Advisory Committee from the American Academy of Ophthalmology, and Dr. Anette M. Phelan represents the National Society for the Prevention of Blindness.

Dr. Bradshaw's committee includes Dr. Lee H. Ferguson, of Western Reserve University, Cleveland; Dr. L. M. Hickernell, of Syracuse University, Syracuse, N. Y., and Dr. Ruby L. Cunningham, of the University of California, Berkeley.

The inadequacy of present methods of discovering college students who need ophthalmic attention has impelled the American Student Health Association to seek the active help of ophthalmologists in dealing with this problem, according to Dr. Bradshaw.

Serving on Dr. Benedict's committee of ophthalmologists are Dr. LeGrand H. Hardy, of New York, and Dr. Harry S. Gradle, of Chicago.

GENERAL NEWS

Sight Saving Week.—The Sight Saving Council of Memphis, Tenn., in which the ophthalmologists of the city cooperated, sponsored a Sight Saving Week in Memphis, January 10 to 14, during

which pertinent information pertaining to conservation of vision from the medical and the practical standpoints, including those of accident prevention, illumination and industry, was dispersed by lectures and radio to a vast audience. More than ten thousand persons were personally addressed by Mr. Milton Bowman, of Cleveland, who used slides pertaining to the conservation of the eye in relation to traffic and industrial hazards.

Course in Ophthalmology.—An intensive course in ophthalmology will be given by Dr. Sidney Olsho and Dr. L. Waller Deichler, of Philadelphia, April 4 to 9, 1938. Further information can be secured by writing Dr. George W. Mackenzie, 269 South Nineteenth Street, Philadelphia.

American Board of Ophthalmology.—Examinations for certification in ophthalmology will be conducted by the American Board of Ophthalmology in accordance with the following schedule: San Francisco, June 13; Washington, D. C., October 8; Oklahoma City, November 15.

Application for examination should be sent to the office of the American Board of Ophthalmology, 6830 Waterman Avenue, St. Louis.

UNIVERSITY NEWS

Study in Physiologic Chemistry.—The department of ophthalmology of the University of Chicago is making an extended effort to build up an interest in physiologic chemistry in relation to ophthalmology, under the guidance of Dr. A. C. Krause, and will welcome graduate students in this special field.

Obituaries

ISADORE GOLDSTEIN, M.D.

1879-1937

Isadore Goldstein died on Dec. 23, 1937. Turning from the practice of general medicine, he began his career in ophthalmology at the New York Eye and Ear Infirmary in the clinic of Dr. John E. Weeks, who encouraged him in his interest in plastic surgery of the eye. After Dr. Weeks' retirement in 1919, he came under the influence of Dr. John M. Wheeler, who guided his further development in this branch of surgery. He soon emerged as an accomplished surgeon, with a deep interest in and unusual talent for reconstructive work. From 1929, as senior assistant surgeon in Dr. Bernard Samuels' clinic, he was afforded every opportunity to develop and demonstrate his methods of plastic surgery. Extensive procedures requiring several operations were so carefully devised as to require little deviation from the original plan in their execution. Postoperative dressings received the same meticulous care as the operation itself. In a field in which successful results are not the rule, his were unusually numerous. Among the procedures he devised were: recession of the levator muscle for the relief of exophthalmos in cases of exophthalmic goiter, construction of lids for the retention of prosthesis following exenteration of the orbit and the replacement of diseased conjunctiva of the upper lid with buccal mucosa in cases of obstinate vernal catarrh.

Dr. Goldstein's second great interest was ocular pathology, especially in relation to general diseases. In 1928, largely through his efforts, a department of ocular pathology was established at the Mount Sinai Hospital. Numerous articles appeared in the ARCHIVES OF OPHTHALMOLOGY, including those dealing with the histologic picture of melanosis in Recklinghausen's disease, of periarteritis nodosa, of acute lupus erythematosus and of Niemann-Pick's disease and with the effects of irradiation on the eyes of human embryos. In 1932 Dr. Goldstein was appointed ophthalmic surgeon at the Mount Sinai Hospital.

During vacations abroad he was invited to exhibit his surgical skill in Cairo, Paris and Jerusalem. In 1930 he assisted in the establishment of the ophthalmic division of the Hebrew University in Palestine.

He was an indefatigable and conscientious worker, an able teacher, a keen observer who was well informed on many topics in general medicine and a source of comfort to many men in times of "surgical stress."

DAVID WEXLER, M.D.

Abstracts from Current Literature

EDITED BY DR. WILLIAM ZENTMAYER

Anatomy and Embryology

ARE THE CLUMP CELLS OF THE UVEA DERIVED FROM CHROMATOPHORES? A. BAKKER, *Arch. f. Ophth.* 137: 611 (Oct.) 1937.

The clump cells of the uvea may be of ectodermal or of mesodermal origin. The presence of typical clump cells in blue irides, the stroma cells of which contain no pigment, and in fetal irides, in which no uveal pigment has yet been formed, proves the possibility of ectodermal origin. With his method of perfusion of explanted tissue, Bakker has shown that chromatophores under conditions of slightly impaired circulation are transformed into clump cells. Thus, the possibility of a mesodermal origin of the clump cells is also proved.

P. C. KRONFELD.

THE PALPEBRAL FISSURE IN NEGROES. J. L. ROLLIN, *Ztschr. f. Augenh.* 89: 95 (April) 1936.

In a study of 800 typical Negroes from many African tribes, Rollin found only 2 whose palpebral fissure sloped down temporally while in eight the outer canthus was definitely higher than the inner canthus. This would disprove the existence of a negroid facial characteristic proposed by Rontils, who states that the outer commissure is typically lower than the inner commissure in the Negro.

H. GIFFORD JR.

Biochemistry

THE SPERMINE BASES OF OCULAR TISSUES. A. C. KRAUSE, *Am. J. Ophth.* 20: 508 (May) 1937.

Krause gives the following summary:

"A quantitative analysis of the spermine and spermidine in bovine conjunctiva, sclera, corneal epithelium and stroma, choroid, iris, vitreous humor, retina, optic nerve, and brain was made. There is reason to believe that these substances take a part in some unknown important physiological function of active metabolic tissues."

W. S. REESE.

LACRIMAL ELIMINATION OF DEXTROSE IN HYPERGLYCEMIA INDUCED BY EPINEPHRINE. D. MICHAÏL, P. VANCEA and N. ZOŁOG, *Compt. rend. Soc. de biol.* 125: 1095, 1937.

Hyperglycemia induced by epinephrine is regularly accompanied by the lacrimal elimination of dextrose. The dextrose in the tears is demonstrable in from twenty to seventy minutes after the injection of epinephrine. Lacrimal elimination commences when the sugar content is from 30 to 40 per cent above normal. This fact shows that up to a certain point the threshold of lacrimal elimination of dextrose is lower than that of renal elimination.

J. E. LEBENSOHN.

Congenital Anomalies

COLOBOMA OF THE MACULA LUTEA IN MONOZYGOTIC TWINS: REPORT OF A CASE. K. VOGELSANG, *Klin. Monatsbl. f. Augenh.* 98: 322 (March) 1937.

Vogelsang reports in detail the cases of two male twins aged 8 years with colobomas in their right eyes. The boys showed mirror-like asymmetries of their fingers, ears, features, form of palate, teeth and tongue and various other structures. The father's eyes were normal in form and function, except for irregular pupils, deep physiologic excavation of both disks and slight lighter discoloration of the temporal portion of the choroid. Vision was normal in each eye. The mother had juvenile glaucoma, which may constitute a correlation to the malformation in the eyes of the twins. Vogelsang considers the colobomas malformations because of their concordant occurrence in monozygotic twins and because no further changes occurred in the fundi during eight years. The literature in point is cited.

K. L. STOLL.

Cornea and Sclera

SCLEROMALACIA. F. A. KIEHLE, *Am. J. Ophth.* 20: 565 (June) 1937.

A 64 year old woman had had rheumatism since the age of 21. She had been bedridden for nine years because of deforming polyarthritis, practically all her joints being affected. When the author first saw the patient, her eyes showed slaty gray scleras, described as "vitrification," the thinned scleras allowing the choroid to show through. The episcleral tissue after a stage of edematous swelling gradually was absorbed. The media were clear and the fundi were normal, but later both lenses became opaque and the eyes sightless, and in recent years multiple radiating perforations occurred in each iris. Kiehle compares this case to others reported in the literature and discusses the relation of the condition to arthritis.

W. S. REESE.

ON MEGALOCORNEA (CLINICAL CONTRIBUTION AND PATHOGENIC CONSIDERATION). V. PATERNOSTRO, *Ann. di ottal. e clin. ocul.* 64: 846 (Dec.) 1936.

Paternostro describes three cases of bilateral megalocornea of the familial type, in one of which there was corectopia. He reviews the various theories of the origin of the condition and then attempts to evaluate the embryologic factors. He concludes that megalocornea is produced on the marginal portions of the secondary optic cup by abnormal differentiation.

F. P. GUIDA.

HEMATOLOGIC STUDIES IN CASES OF SYPHILITIC INTERSTITIAL KERATITIS. A. MOTEGI, *Arch. f. Ophth.* 137: 527 (Oct.) 1937.

Motegi compares the hematologic findings for patients with syphilitic interstitial keratitis with those of normal controls and for persons with other corneal diseases. He reports an enormous amount of data, which do not lend themselves to abstracting.

P. C. KRONFELD.

CLEARING OF THE OPAQUE TRANSPLANT BY ADDITIONAL KERATOPLASTY. S. WELTER, *Vestnik oftal.* 10: 643, 1937.

The technic of additional nonpenetrating or penetrating transplantation at the site of the opaque transplant is described. Three eyes in which the transplants were opaque for eleven, thirteen and thirty-five months, respectively, were operated on by Filatov's method of additional transplantation of fresh corneal tissue around the old transplant. All the opaque transplants became semitransparent within two or three months. This procedure gives new hopes as to the possibility of combating the opacification of corneal transplants.

O. SITCHEVSKA.

AUTOHEMOTHERAPY OF CORNEAL ULCERS. A. B. KOLENKO, *Vestnik oftal.* 10: 820, 1937.

The purpose of this experimental work was to determine the value of autohemotherapy in cases of purulent ulcer of the cornea, its prophylactic action and its mechanism of action according to the morphologic changes of the leukocytes in rabbit's blood. Thirty-six rabbits were used for the experiment. From five to seven injections of from 0.1 to 0.15 cc. of blood per kilogram of body weight were given. The experiment was divided into five parts, as follows: Staphylococcic corneal ulcers were treated with general autohemotherapy (subcutaneous injections) and with local autohemotherapy (subconjunctival injections); corneal ulcers were produced by smallpox vaccine, and the prophylactic action of general and of local autohemotherapy against the staphylococcic infection of the cornea was investigated. Repeated examinations of the blood were done on ten rabbits. An ulcer was produced by the introduction of an emulsion of a pure culture of *Staphylococcus aureus* into the anterior chamber and into the deep layers of the cornea. The cure of the ulcer was considered complete when it was covered with epithelium. Kolenko came to the following conclusions on the basis of his experiments:

1. A corneal ulcer is best produced in the rabbit by the introduction of an emulsion of staphylococci into the deep layers of the cornea, because the doses can be regulated and excessive irritation is avoided.
2. An experimental ulcer has a tendency to self cure.
3. Smallpox vaccine has no advantage over the staphylococcus emulsion as an infectious material for the production of a corneal ulcer.
4. Subcutaneous or subconjunctival autohemotherapy shortens the duration of purulent keratitis about 8 per cent as compared with the course of a control ulcer.
5. Prophylactic autohemotherapy, general or local, does not prevent the development of an experimental ulcer, but the course is sluggish and the time of epithelization is shortened as compared with these factors in a control ulcer.
6. The number of white and red blood cells and the leukocytic formula in rabbits vary individually. The change of the morphologic picture could not be systematized.
7. Autohemotherapy, local or general, is a favorable factor in the treatment of experimental ulcer.

O. SITCHEVSKA.

Experimental Pathology

THE FUNDUS OCULI OF THE RABBIT WITH VITAMIN A DEFICIENCY.

F. SCULLICA and E. FULCHIGNONI, *Ann. di ottal. e clin. ocul.* 65: 427 (June) 1937.

Spotted or brown rabbits were placed on a diet deficient in vitamin A. The fundi were observed after dark adaptation of thirty minutes and after exposure of one eye to a light of 500 foot candles for four hours. The fundus of the exposed eye was compared with that of the unexposed eye at various intervals after exposure and with that of a rabbit on a normal diet and treated to the same exposure. In animals on a diet deficient in vitamin A as well as in those on a normal diet, a definite decoloration of the fundus was observed in the eye exposed to light. This decoloration was attributed to bleaching of the visual purple. In animals on a normal diet the color returned to normal in from seventeen to eighteen hours after exposure, while in those on the deficient diet the difference in color persisted much longer, the length of time required for a return to the normal color being proportional to the severity of the deficiency in vitamin A.

In addition to this decoloration, there was seen in normal animals, and more markedly in animals with vitamin deficiency, a change in pigmentation of the fundus after exposure to light. The homogeneous pigmentation of certain areas was replaced by smaller zones of pigment-forming islands and archipelagos of pigment surrounded by clear areas in which the choroidal vessels were clearly seen. The phenomenon was reversible after dark adaptation but became less so in animals with more severe vitamin deficiency. Another phenomenon observed was the appearance of medullated nerve fibers, which extended from the disk to the periphery in all directions after exposure to light. After dark adaptation, this picture was replaced by the normal one, showing the medullated nerve sheaths only near the optic disk. The changes described were all seen at a time before the symptoms of xerosis and keratomalacia occurred.

S. R. GIFFORD.

General

THE EYE HOSPITAL AT SHIKARPUR, INDIA. R. BUXTON, *Brit. J. Ophth.* 21: 605 (Nov.) 1937.

Buxton gives a vivid description of the adverse conditions under which operations were performed at the Eye Hospital at Shikarpur at the time Sir Henry Holland took charge in 1910. Under his supervision as medical missionary of the Church Missionary Society at Quetta, conditions nowadays are much better. During a stay of about eight weeks this year of the three visiting ophthalmic surgeons, 3,400 operations, including 1,427 cataract extractions, were performed. On the busiest day the total number of operations was over 170, including 96 cataract extractions. Chronic glaucoma is treated either by Elliot's trephine operation or by a broad iridectomy. On the basis of the results, Holland finds little choice between the two methods. He prefers the intracapsular method for cataract extraction, using a modification of the Smith method.

W. ZENTMAYER.

IS THE ARTIFICIAL EYE A CURATIVE OR AN AUXILIARY REMEDY?

C. QUINT, *Klin. Monatsbl. f. Augenh.* 98: 347 (March) 1937.

The question whether a glass eye is only an auxiliary remedy, desirable for cosmetic effect, or an actual curative agent is of great importance in problems arising in regard to workmen's compensation.

Quint reasons that from the medical standpoint an artificial eye has a predominantly curative value and, secondarily, an auxiliary value. The cure is not finished with the enucleation, because a condition remains which is not physiologic. The lids, being deprived of their support, sink back and exert a constant friction on the conjunctiva. This leads to thickening of the conjunctiva and increased secretion and finally to atrophy of the conjunctiva. Mucopurulent discharge frequently produces eczema of the lids and the adjacent areas, and irritation may be transmitted to the other eye. These conditions can be prevented by constant use of an artificial eye. Therefore, the curative value of a glass eye is equal at least to that of spectacles.

K. L. STOLL.

General Diseases

OCCURRENCE OF SO-CALLED THROMBO-ANGIITIS OBLITERANS IN THE EYE. Y. UYAMA, *Arch. f. Ophth.* 137: 438 (Aug.) 1937.

Uyama reports the cases of two patients (a Japanese man aged 24 and a Japanese woman aged 35) who showed pallor of the entire skin, cyanosis of the extremities, hippocratic fingers and toes and circumscribed loss of sensibility on the extremities. Ophthalmoscopically, the picture was that of the late stages of perivasculitis and endovasculitis, arteries as well as veins being involved. Long stretches of retinal vessels were transformed into white strands or accompanied by white sheaths. One eye of one of the two patients became available for pathologic examination, which revealed chiefly proliferation of the intima, new formation of elastic lamellae and no signs of inflammation. These anatomic observations are the same as those described in other organs in cases of Buerger's disease.

P. C. KRONFELD.

Glaucoma

LECTURES ON GLAUCOMA. R. E. WRIGHT, *Am. J. Ophth.* 20: 462 (May) 1937.

This article does not lend itself to abstracting and deals with glaucoma particularly as it occurs in India. Wright speculates on the possibility of glaucoma's being systemic in origin and discusses epidemic dropsy, which has primary glaucoma as one of its clinical manifestations. As epidemic dropsy is due to ingestion of a certain type of rice, he infers that glaucoma may be caused by ingested toxins, defective ingestion or abnormal metabolites elaborated in the body from normal foods.

W. S. REESE.

LECTURES ON GLAUCOMA. R. E. WRIGHT, *Am. J. Ophth.* 20: 571 (June) 1937.

This lecture on the operative treatment for glaucoma does not lend itself to abstracting. Wright takes up sclerocorneal trephining, the Lagrange decompression, iridencleisis, cyclodialysis and posterior sclerotomy. He discusses the complications and the postoperative treatment of trephining.

W. S. REESE.

PATHOGENESIS AND THERAPY OF HEMORRHAGIC GLAUCOMA, WITH ESPECIAL REFERENCE TO CONTINO'S ANTERIOR FORM. G. FAVALORO, *Ann. di ottal. e clin. ocul.* 65: 241 (April) 1937.

Favaloro presents clinical evidence in support of Contino's contention that in certain cases of glaucoma there is a distinct syndrome, which is amenable to mydriatics instead of miotics and in which the eyes are especially prone to hemorrhages. Although the cases reported by Contino are not very convincing, he believes that they aid in separating the usual type of glaucoma, due in his opinion to swelling of the vitreous, from the anterior type. The latter he considers as primarily an angiopathy, the increased tension being secondary to vascular disturbances in the iridocorneal angle. The benefits of scopolamine and atropine in such cases depend on their decongestive effect.

S. R. GIFFORD.

Lens

TECHNIQUE OF CATARACT EXTRACTION DURING NARCOSIS. BASIL GRAVES, *Brit. M. J.* 2: 319 (Aug. 14) 1937.

In order to avoid lack of cooperation and mental strain on the part of the patient during an operation for the extraction of cataract, Graves, in addition to the usual local injection of procaine hydrochloride, induces narcosis of a degree sufficient to abolish all consciousness. The state of sleep lasts from seven to fourteen hours after the operation, and the unpleasant after-effects, such as vomiting, abdominal pain, delirium and retention of urine, are thereby eliminated. The author's method consists in the use of paraldehyde rectally, accompanied by a hypodermic injection of a mixture of opium alkaloids (omnophon). Bromides are given by mouth during the preceding twenty-four hours. The pupil is dilated with two swabs of cotton wool soaked, respectively, with a 2 per cent solution of homatropine hydrobromide and a 1:1,000 dilution of epinephrine hydrochloride and inserted under the upper eyelid.

The author also fully describes his modified technic of cataract extraction, which consists of a rather intricate suture of the cornea and the sclera. After the usual section, without iridectomy, a piece of the anterior capsule of the lens is removed with a capsule forceps. The same method of inducing anesthesia is used in cases of glaucoma in which trephination is performed. Illustrations of the author's technic of cataract extraction accompany the article.

ARNOLD KNAPP.

URICACIDEMIA AND CATARACT. G. VILLANI, *Ann. di ottal. e clin. ocul.* 65: 306 (April) 1937.

The uric acid content of the blood of sixty patients with cortical cataract was determined. Patients with nuclear cataract were not included in the study. Only two patients were known to be subject to gout. The normal figure was considered to be from 0.04 to 0.05 per cent. Only one patient had a low uric acid content—0.031 per cent. The values for twenty-five patients ranged between 0.051 and 0.06 per cent; for ten patients, between 0.061 and 0.07 per cent; for one patient, between 0.07 and 0.08 per cent; for six patients, between 0.081 and 0.09 per cent, and for two patients, between 0.091 and 0.1 per cent. The higher values, as a rule, were obtained for patients over 65 years of age. Seven patients with trachoma, used as controls, had uric acid contents varying from 0.042 to 0.05 per cent. Thus it must be considered that forty-four of the sixty patients showed an elevation of the uric acid content of the blood, and hence this change in purine metabolism must be considered a possible factor in the production of cortical cataract.

S. R. GIFFORD.

Lids

TARSITIS SYPHILITICA. H. KHALIL, *Brit. J. Ophth.* 21: 648 (Dec.) 1937.

Khalil reports a case of syphilitic tarsitis in a woman aged 65. She had suffered from enlarged glands in the axilla for three years, for which she underwent an operation. Glandular enlargement all over the body followed the operation. There was thickening of all four lids, with ptosis of both upper lids. There were no other ocular symptoms. The Wassermann reaction of the blood was 3 plus.

The author gives a detailed clinical and pathologic account of the disease.

The article is illustrated.

W. ZENTMAYER.

Methods of Examination

THE MONOCHROMATIC LIGHT OF THE SODIUM VAPOR LAMP AS A SOURCE OF LIGHT IN OPHTHALMOSCOPY. H. SERR, *Arch. f. Ophth.* 137: 636 (Oct.) 1937.

Because of the fact that yellow rays penetrate fog better than white (mixed) rays, sources emitting yellow rays are used more and more for the lighting of roads (headlights of automobiles). The sodium vapor lamp furnishes pure monochromatic (yellow) rays. With such a lamp as a source of light, interesting and important ophthalmoscopic observations can be made. In eyes with opacities of the media, yellow rays give an ophthalmoscopic picture which is brighter and contains more details than the picture obtained with white (mixed) rays. The yellow rays even penetrate the normal pigment epithelium and thus make visible the choroidal vessels and pathologic changes within the

choroid (hemorrhages). All blood vessels in the fundus appear black and stand out clearly against the yellowish gray fundus. Actual tears of the retina can be distinguished from mere thinnings.

P. C. KRONFELD.

Neurology

ESSENTIAL NEURALGIA (?) OF THE TRIGEMINAL NERVE (OPHTHALMIC BRANCH) DUE TO BACILLARY TOXEMIA: TUBERCULIN THERAPY. C. CHARLIN, *Ann. d'ocul.* 174: 588 (Sept.) 1937.

In a former communication by Charlin a case was reported in which the patient suffered for several months with tenacious neuralgia of the nasal nerve, which disappeared after a routine Mantoux test. It had not reappeared after a year and a half. In the months following the disappearance of the neuralgia the patient received a course of tuberculin treatment.

In the same communication there was reported a syndrome of the nasal nerve associated with ulcerative keratitis which had resisted all local and general treatment but showed a spectacular amelioration after a Mantoux test.

According to the author, there have been many cases of blepharitis, conjunctivitis and scrofulous keratitis in which the condition was uninfluenced by any local or general treatment but cleared up after injections of tuberculin. To clarify this statement, he gives in minute detail the treatment and course in such cases.

S. H. McKEE.

HISTOLOGIC AND MICROBIOLOGIC STUDIES OF THE OPTIC NERVE IN CASES OF DEMENTIA PARALYTICA. A. BIFFIS, *Ann. di ottal. e clin. ocul.* 65: 161 (March) 1937.

The literature is reviewed in regard to the finding of spirochetes in the central nervous system and especially in the visual pathways. The author employed the two methods of Jahnke on material obtained at autopsy from eleven patients who had had dementia paralytica. Spirochetes were found in the cerebral cortex in nine instances. They were found in the region just adjacent to the chiasm once. In only one instance were they identified in the optic nerve itself, in an area of softening and sclerotic connective tissue. The technical difficulties are emphasized, since in two instances intense impregnation with silver nitrate made it difficult to be sure that spirochetes were not present. The organisms in the cortex were found entirely in the gray matter and usually in areas of perivascular infiltration. The autopsy specimen in which spirochetes were found in the optic nerve was the only one showing histologic evidence of atrophy of the optic nerve. The patient from whom this specimen was removed had been inoculated with malaria, which had resulted in an exacerbation of general symptoms. Photomicrographs and a bibliography accompany the article.

S. R. GIFFORD.

Ocular Muscles

HEREDITARY PARALYSIS OF THE ABDUCENS NERVE. R. C. LAUGHLIN, *Am. J. Ophth.* 20: 396 (April) 1937.

Laughlin reports a case of hereditary paralysis of the left external rectus muscle in a child whose mother exhibited a typical Duane syndrome. He briefly reviews the literature and gives the following summary:

"A case of hereditary paralysis of the abducens nerve is presented, in which five members in three generations of the same family were afflicted; two were examined. Ten other cases are reported from the literature. A statistical analysis of the data shows that in this condition a majority of females and of left eyes are affected." W. S. REESE.

SQUINT AND HETEROPHORIA, WITH SPECIAL REFERENCE TO ORTHOPTIC TREATMENT. W. H. McMULLEN, *Brit. M. J.* 2: 1015 (Nov. 20) 1937.

McMullen first reviews the theories which have been advanced to explain concomitant strabismus. They are: (1) the muscular theory, (2) the accommodation theory and (3) the theory of defective fusion faculty. In addition, the influence of hereditary anisometropia, of nervous factors and of social conditions must be considered. In conclusion, the author says that no one of these theories alone can explain the disorder and that probably squint is a clinical condition due to a number of causes.

An interesting description of the development of orthoptic treatment is given. The author was one of the first to attempt treatment along the lines outlined by Worth, but he did not obtain satisfactory results and became skeptical as to its value. It is not stated whether with the new development of orthoptic treatment he has changed his mind.

ARNOLD KNAPP.

Operations

SIMULTANEOUS DOUBLE PARACENTESIS OF THE CORNEA FOR ISOLATION OF CICATRICIAL PROLAPSES OF THE IRIS. A. MARKOVIĆ, *Klin. Monatsbl. f. Augenh.* 98: 187 (Feb.) 1937.

Denig suggested iridectomy on each side of the prolapse for the isolation of a cicatricial prolapse of the iris or on one side of the prolapse in cases in which a coloboma of the iris is present. Marković has constructed an instrument with which paracentesis can be performed simultaneously on the two sides of the prolapse. It consists of a double lance knife with nearly straight inner sides. The blades are connected by crossed handles and can be set closer together or farther apart by means of a screw, according to the width of the prolapse. The iris is excised on each side of the prolapse by means of an iris forceps. An iris hook may be employed in aphakic eyes.

K. L. STOLL.

Parasites

OPHTHALMOMYIASIS INTERNA: REPORT OF A CASE. I. DERER, Klin. Monatsbl. f. Augenh. 98: 339 (March) 1937.

A boy aged 7 years had suffered from inflammation of his right eye for from six to seven weeks. It was caused by a larva of a fly, *Wohlfartia magnifica* (Sarkophaga), in the anterior chamber. The larva was about 7 mm. in length and 1 mm. thick and consisted of nine segments. After extraction, it coiled up spirally. The vision was greatly reduced, the intra-ocular tension was increased to 60 mm. (Schiötz) and the lens was subluxated upward and toward the nose, so that its lower margin appeared in the pupil. The eye became free from irritation soon after operation, and the vitreous cleared sufficiently for Derer to observe through the clear space below the lens that the disk was atrophic and that the retinal vessels were decidedly narrowed. Vision remained limited to perception and projection of light. The condition of the disk and retinal vessels led Derer to believe that the larva entered the eyeball by way of the blood stream. The sclera, which was intact in this case, would, however, have offered no obstacle to the entry of this kind of larva, which is known to pierce even sinews and bones.

K. L. STOLL.

Pharmacology

REACTION OF OCULAR TISSUES UNDER THE INFLUENCE OF CHEMICAL AND PHARMACOLOGIC SUBSTANCES INTRODUCED INTO THE ANTERIOR CHAMBER AND VITREOUS. M. CORRADO, Ann. di ottal. e clin. ocul. 64: 145 (March); 520 (Aug.); 811 (Dec.) 1936; 65: 361 (May) 1937.

Corrado presents an extensive introductory review of the literature on the use of chemical and pharmacologic substances for the treatment of intra-ocular disease. The purpose of his investigation was to accumulate evidence as to the effects of many substances in the eye, so that eventually some rationale may be established for their use. The substances used were of two types, chemical (hydriodic acid, tartaric acid, trinitrophenol, lactic acid, formic acid, acetic acid, hypertonic, isotonic and hypotonic solutions of sodium chloride, ammonia, hydrogen peroxide and alcohol) and pharmacologic (compounds of calcium and gold, mercuric chloride, mercuric iodide, electrocolloidal iron, sulfur, arsenic and iodine).

The method consisted mainly in the injection of increasingly larger amounts of the compound used into the vitreous of a rabbit until a definite reaction was observed clinically. A similar procedure was followed in the anterior chamber.

The author arrives at the following conclusions:

1. Ocular tissues react with decreasing violence to chemical substances in the following order: acids, alkalis, sodium chloride, hydrogen peroxide and alcohol. Of the pharmacologic substances, mercuric chloride and mercuric iodide cause the most violent reaction, followed in order by compounds of calcium, gold, bismuth, sulfur, arsenic, iodine and electrocolloids of iron and silver.

2. At first the tissues react only slightly, but later the reaction is more intense. Such reactions are definitely inflammatory and depend on the concentration of the substance rather than on its physiochemical nature.

3. Histologically, the reaction is of an intense but diffuse inflammatory nature. Rarely (as in the case of alcohol in the anterior chamber) does atrophy of tissue take place without an inflammatory reaction. No histologic change was noted after the use of sodium chloride (physiologic solution).

4. The anterior chamber can tolerate higher concentrations of the same substance than the vitreous.

In summary, all acids and alkalis in weak or strong solutions act as irritants, causing detrimental changes in the tissue. Of the pharmacologic group of substances, mercuric chloride, mercuric iodide, bismuth and neoarsphenamine produce even in weak concentration lesions that are harmful to the structure and function of the tissues. The best tolerated substances are the iodides (in the anterior chamber), physiologic solution of sodium chloride (in the anterior chamber and vitreous) and electrocolloids of silver and iron (in the anterior chamber and vitreous).

F. P. GUIDA.

Physiology

A STUDY OF THE COMMUNICATION AND DIRECTION OF FLOW BETWEEN CEREBROSPINAL FLUID AND OPTIC DISCS IN THE RAT. J. Q. GRIFFITH JR., W. A. JEFFERS, A. G. FEWELL and W. E. FRY, *Am. J. Ophth.* 20:457 (May) 1937.

Griffith, Jeffers, Fewell and Fry give the following summary of their experiments on adult albino rats:

"1. The passage of thorotrast from the cerebrospinal space to the optic disc regions has been demonstrated by the X-ray and by histologic examination.

"2. In 16 rats rendered hypertensive by previous intracisternal injection of kaolin, thorotrast injected intracisternally failed to appear under X-ray examination and was distinctly less evident histologically in the optic-nerve sheaths or disc regions.

"3. The evidence supports the view that the normal direction of fluid flow in the perineural spaces of the optic nerves is from the cerebrospinal space toward the optic discs.

"4. The bearing of this on the mechanism of papilledema is discussed."

W. S. REESE.

ANALYSIS OF THE SPONTANEOUS PULSATION OF THE RETINAL VESSELS. H. SERR, *Arch. f. Ophth.* 137:478 (Oct.) 1937.

A man aged 70 with unilateral glaucoma simplex and without signs of cardiovascular disease showed the same type of spontaneous venous pulsation in both eyes, to which when the tension of the glaucomatous eye rose above 36 a typical arterial pulsation was added. Serr photo-

graphed these pulsation phenomena with a special motion picture camera made for this purpose by Dr. Hartinger. The pictures allowed exact determination of the temporal relation between arterial and venous pulsation. The proximal end of the retinal veins collapsed during the systole, while the retinal arteries collapsed during the last third of the diastole. The collapse of the veins coincided with and exactly paralleled the pulsatory increase in intra-ocular pressure. Thus, it was proved that the pulsatory variation of the intra-ocular pressure caused the venous pulsation.

P. C. KRONFELD.

Retina and Optic Nerve

ANGIOGLIOSIS RETINAE WITH REPORT OF TWO CASES. I. CZUKRÁSZ, Brit. J. Ophth. 21: 368 (July) 1937.

The clinical notes on two cases of angiogliosis of the retina are given. In each case the eye was studied histologically. In the first case the ganglion cells were destroyed. The nuclei of the inner nuclear layer and the cones and rods were partially necrotic, and glial tissue was abundant between the nerve and Müller's fibers and among the remaining desolate neural elements. The vessels were increased in size and number throughout the retina, and the perithelium was thickened with hyaline degeneration. A tumor 2 mm. in width was lying posterior to the ora serrata behind and connected with the retina. It was composed of hyaline degenerated tissue, cholesterol crystals and vessels. In the neoplasm were irregularly shaped spaces of various sizes, lined by endothelium and occasionally containing some blood. In some parts aneurysms were present.

In some sections at the ora serrata the retina was indefinitely divided into two layers. One layer was supposed to be of neuro-epithelial structure and the other of neural element. It was of interest that the tumor cells invaded the two primary structures of the retina, and the choroidal vessels.

In the second case a strange, reddish gray, dichotomic, worm-shaped formation was seen in the upper part of the globe between the retina and the choroid. The mass was growing to the temporal edge of the optic disk; it continued to the lower surface of the globe and extended like a fan onto the adjoining retina. The histopathologic picture of the retina was similar to that in the first case.

Czukrász surmises that in these two cases the neoplasm that was found, combined with the glaucoma, was responsible for the destruction of the retina. The tumors were classified as hamartoma of the same type as the dysontogenetic tumors of the central nervous system. They are of ectodermal origin, and the initiating cause lies in the neuro-epithelium.

The article is illustrated.

W. ZENTMAYER.

RESULTS OBTAINED WITH SYMPATHECTOMY IN ATROPHY OF THE OPTIC NERVE AND PIGMENTARY DEGENERATION OF THE RETINA. F. BLOBNER, Klin. Monatsbl. f. Augenh. 98: 289 (March) 1937.

Blobner discusses the idea of employing hyperemia therapeutically in diseases of the choroid, retina and optic nerve. Quoting investigators

in this field, Blobner refers to the results obtained with sympathectomy in atrophy of the optic nerve and in pigmentary degeneration of the retina. Magitot reported satisfactory results, which could not be substantiated by Löwenstein. Blobner reports the results obtained at the Eye Clinic of the University of Prague. Sympathectomy was done on thirteen male patients. Of these, six suffered from tabetic atrophy of the optic nerve; one had congenital syphilitic choroiditis associated with pale optic disks, and six had pigmentary degeneration of the retina. Eleven cases are described and illustrated with sketches of the fields of vision. The operation yielded no improvement in the six patients with tabetic atrophy of the optic nerve. Retardation of the pathologic process was only temporary in one of these patients, in whom the atrophy had advanced slowly for about five years prior to the operation.

The outcome was still more disappointing in the patients with pigmentary degeneration of the retina, in whom vision decreased and the field of vision became narrower after the operation. No difference in the volume of the retinal vessels could be noted with the ophthalmoscope. Disastrous complications, such as those reported by Abadie, Wilbrand, Kerr and others, did not occur.

Because of the result in these cases it was decided to abandon this none too harmless operation for the diseases just discussed.

K. L. STOLL.

Trachoma

GUIDE TO THE TREATMENT OF TRACHOMA. E. CORNET, *Rev. internat. du trachome* 14: 183, 1937.

There is no specific remedy for trachoma. Mechanical methods are of primary importance; chemicals are but adjuvant remedies and are especially valuable in the treatment of a secondary infection. The ends to be achieved are: evacuation of follicles, subsidence of papillary hypertrophy, resorption of pannus and cicatrization of ulcers.

J. E. LEBENSOHN.

TRACHOMA OF THE FORNIX. E. CORNET, *Rev. internat. du trachome* 14: 194, 1937.

Trachoma confined to the fornix is fairly frequent though difficult to detect except in the cicatricial stage. Since trachoma does not exist without involvement of the cul-de-sac, the latter must be considered the primary seat of the disease.

J. E. LEBENSOHN.

HEALING OF TRACHOMA. E. OLAH, *Klin. Monatsbl. f. Augenh.* 98: 350 (March) 1937.

Olah discusses the disputed question of the infectiousness of trachoma, which remains unsettled. It is safe to say that untreated trachoma is infectious whereas healed trachoma is not. A case to the contrary is reported. A man had trachoma twenty-five years before the present examination and had been considered cured by several oculists. Two years prior to observation of the patient by Olah, the right

eye became blind owing to a severe corneal ulcer, with remaining leukoma. A corneal ulcer developed in the left eye three weeks prior to the patient's admission to the clinic. At the time of admission the lower two thirds of the cornea was involved by a serpent ulcer. Separated from it, typical trachomatous pannus presented in the upper third of the cornea. The trachoma had been incompletely healed, in Olah's opinion, although it had become noninfectious, but had regained its infectiousness as soon as another infection occurred.

K. L. STOLL.

Uvea

CHRONIC TUBERCULOUS UVEITIS. H. D. LAMB, *Am. J. Ophth.* 20: 490 (May) 1937.

Lamb reports a case of bilateral uveitis in a Negress in whom both eyes were eventually enucleated. He gives the following conclusions:

"This case is a typical example of chronic ocular tuberculosis as emphasized by F. H. Verhoeff. According to this writer, a condition is established in these cases in which the tissues of the host and the infecting organisms have become relatively tolerant to each other. The characteristic features in these cases are the following: Chronic ocular tuberculosis almost never occurs in cases in which there are well-marked clinical signs of systemic tuberculosis. Although chronic ocular tuberculosis is rare compared with the incidence of tuberculosis in general, yet when it occurs it is almost always sooner or later bilateral. It occurs almost exclusively in adults and far more frequently in females. The temperature is almost never elevated and is often subnormal. A large dose of tuberculin is usually required to produce a constitutional reaction and rarely a tuberculin reaction cannot be obtained at all. Animal inoculations of the lesions usually if not always give negative results."

W. S. REESE.

IS FUCH'S HETEROCHROMIA STILL TO BE CONSIDERED AS A MORBID ENTITY WITH ITS OWN PATHOGENESIS? J. STREIFF, *Ann. di ottal. e clin. ocul.* 65: 298 (April) 1937.

In view of a recent report by Biozzi, who claimed that heterochromia is of tuberculous origin, Streiff refers to his previous extensive review on the question of heterochromia as a morbid entity with its own pathogenesis and discusses the subject. He concludes that true heterochromia must still be considered a morbid entity, which is related in etiology to disturbances in sympathetic innervation and to the status dystrophicus described by Passow.

S. R. GIFFORD.

Vision

THE RECOGNITION OF FLASHING COLOURED LIGHTS BY PERSONS WITH NORMAL AND DEFECTIVE COLOUR VISION. H. V. CORBETT and H. E. ROAF, *Brit. J. Ophth.* 21: 592 (Nov.) 1937.

In testing for color vision it is important to vary the duration of exposure, as flashing lights and stationary lights viewed from a tossing vessel may be visible only for a short interval of time at each exposure.

The authors describe the lantern used and the methods of examination pursued. They give the following summary:

"Our results support those of Guttman (1907, 1908) in showing that the person with defective colour vision is more dependent than the normal subject upon (a) the size of aperture, i. e., the angular aperture of a coloured light; (b) the brightness of the lights, and (c) the duration of exposure.

"It would seem that there are gradations in the degree of the defect so that one can recognize many degrees of defective colour vision. By the hypochromat red is more frequently named correctly than is green. This may be accounted for by the fact that the latter is less saturated or in other words it is not so far removed from parts of the spectrum which give rise to the blue sensation: the blue sensation being complementary to the second sensation of the dichromat (see Pitt, 1935)."

W. ZENTMAYER.

Sympathetic Ophthalmia

SUCCESSFUL DEMONSTRATIONS OF THE TUBERCLE BACILLUS IN THE STAINED SECTION OF AN EYE WITH SYMPATHETIC UVEITIS.
J. MELLER, *Ztschr. f. Augenh.* 89: 1 (April) 1936.

A woman 76 years of age had had glaucoma for four years. Physical examination gave essentially negative results for her age, except for a pleural adhesion in the apex of the left lung.

Iridencleisis was performed on the left eye without reducing the tension. One month later an extracapsular extraction for cataract was done on the right eye. Two weeks after operation severe uveitis was seen in both eyes. It did not subside in the right eye until after the left eye was enucleated, one month later.

The postoperative iridocyclitis was clinically characteristic of sympathetic ophthalmia. The greater part of the eye was used for tissue culture. This was found to be macroscopically positive for tuberculosis, and inoculation of an animal produced tuberculosis. Histologic examination of the remaining part of the eye showed only four small epithelioid nodules, which were typical of sympathetic ophthalmia. One was on the posterior surface of the iris, two were in the ciliary body and one larger one was in the choroid. The picture presented by the nodule on the choroid was also very similar to that seen in cases of tuberculosis without necrosis. The remainder of the choroid was scarcely altered. The section, stained after the method of Ziehl and Neelsen, showed tubercle bacilli in large numbers, located chiefly in the region of the pigment epithelium of the retina and the surrounding rods and cones.

In discussing this case, Meller points out many reasons for the negative tissue cultures and the difficulties in finding the bacilli in sections. Meller believes that if one accepts the similarity of the histologic pictures of sympathetic ophthalmia and tuberculosis, discussion as to whether the iridocyclitis in the eye operated on for cataract arose as the result of the operation on the left eye and was true sympathetic ophthalmia or whether it was a disease resulting primarily from the cataract operation is superfluous. He feels that sympathetic ophthalmia of the injured eye is nothing but a chronic (spontaneous) uveitis on a tuberculous basis.

H. GIFFORD JR.

Therapeutics

THE USE OF CONCENTRATED-EPINEPHRINE PREPARATIONS IN GLAUCOMA, IRITIS AND RELATED CONDITIONS. M. WIENER and B. Y. ALVIS, *Am. J. Ophth.* 20: 497 (May) 1937.

Wiener and Alvis discuss the use of different preparations of epinephrine and give the following conclusions:

"1. Concentrated epinephrin is a powerful mydriatic capable of lowering ocular tension, or of producing an acute rise of tension, of causing severe pain, and occasionally unpleasant general symptoms; hence, the first use should be made where the patient can be observed for one or more hours.

"2. Epinephrin is a valuable aid in cases of chronic simple glaucoma in which miotics must be used for prolonged periods in lieu of the preferred surgical measures.

"3. Chronic secondary glaucoma generally does not yield to epinephrin but may do so, and a trial is justified.

"4. After operation for glaucoma, epinephrin may be effective in securing a state in which the tension remains normal for long periods without treatment.

"5. Glaucoma, after needling of cataracts and aftercataract membranes, has been controlled in a large percentage of cases by epinephrin with or without miotics.

"6. Epinephrin is invaluable in breaking up adhesions in cases of iritis and uveitis.

"7. The most convenient form for office and prescription use is as an ointment in a water-soluble base (tragacanth jelly) or in an oily base (petrolatum and lanolin)."

W. S. REESE.

Society Transactions

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AMERICAN OPHTHALMOLOGICAL SOCIETY

HARRY FRIEDENWALD, M.D., Baltimore, *President*

Seventy-Third Annual Meeting, Hot Springs, Va., June 3, 4 and 5, 1937

J. MILTON GRISCOM, M.D., Philadelphia, *Secretary*

BILATERAL METASTATIC CARCINOMA OF THE CHOROID: REPORT OF A CASE. DR. MARTIN COHEN, New York.

This paper was published in full in the October 1937 issue of the ARCHIVES, page 604.

PRECANCEROUS MELANOSIS AND DIFFUSE MALIGNANT MELANOMA OF THE CONJUNCTIVA. DR. ALGERNON B. REESE, New York.

This paper will be published in full, with the discussion, in a later issue of the ARCHIVES.

MELANOMA OF THE IRIS: REPORT OF A CASE. DR. FRED T. TOOKE, Montreal, Quebec.

A pigmented spot in the iris of the right eye had been observed for many years and had not increased in size. More recently it had become definitely larger, and the question of malignancy was raised. Biopsy showed no evidence of malignancy, and there was no recurrence after nine months.

DISCUSSION ON PAPERS BY DRS. COHEN AND TOOKE

DR. WILLIAM ZENTMAYER, Philadelphia: I should like to report a case in connection with Dr. Tooke's paper. In February 1932 a woman aged 27 consulted me because of a growth on her right eye. She stated that from birth she had had a dark spot on the iris of this eye and that it had remained unchanged until two months previous to her visit to me, when it grew rapidly. It then involved one sixth of the circumference of the iris, extending from the pupillary border to the filtration angle, and was slightly elevated and somewhat irregular in contour. Vision in the right eye was 6/6 and in the left eye, 6/25. I succeeded in extirpating the growth in toto, together with some of the normal structure of the iris on each side. At a recent examination there were no signs of a recurrence of the growth. Another interesting feature in connection with this case is that the amblyopic eye, which had a corrected vision of 6/25, now has a vision of 6/9.

The difference between my case and that of Dr. Tooke is that in my case the growth assumed a malignant character. It proved to be a melanotic sarcoma.

DR. JOHN W. BURKE, Washington, D. C.: I wish to report a case similar to that of Dr. Cohen. My patient was followed from the incipency of the metastasis to death.

Mrs. V. M. V., aged 49, was first seen at my office in February 1929. The vision in each eye was 6/4.5. The fundi were normal. She was seen again in March 1931, with vision of 6/4.5 in each eye and normal fundi. On Feb. 15, 1932, I was called to see her, as she had been in bed for a week and had been treated for nervousness by her family doctor. While I was taking her history, she remarked that for several days her vision had been blurred and that she had had subjective light flashes constantly. Externally, the eyes were normal, and no visual tests were made in her home.

On examination of the fundi a grayish mass was seen in each macular region. The mass in the right eye was about 2 disk diameters, and that in the left eye was slightly larger. The mass in the right eye was elevated 4 diopters, and that in the left eye, 5 diopters. The process was entirely subretinal in the right eye; the edges were not clearly defined and were irregular in outline, but the remainder of the fundus was normal. In the left eye there was a small amount of exudate in or on the retina, at the apex of the mass. There were no opacities of the vitreous, and no hemorrhage was seen at any time in the progress of the disease. The tension was normal. The patient remained in the Episcopal Hospital for three weeks. A survey was made, but nothing was found except one infected tooth, which was removed.

During the patient's stay in the hospital there was no change in the fundi. A second physical examination was made. At this time a small lump, about the size of an English walnut, was found close to the wall of the chest, at the upper part of the breast, which had not been detected at the first examination.

The patient was under periodic observation during April, with no particular change occurring in the eyes. Her vision, taken somewhat roughly in her apartment, was 6/50 in each eye. Her subjective symptom of light flashes remained unchanged. Early in April she called attention to the presence of lumps in the upper part of her left arm, in the postcervical region on the left side, under the left breast and in the postcervical region on the right side. These growths did not enlarge after their initial appearance. On May 1 a detachment of the retina was found in both eyes.

The patient died suddenly on May 20. Autopsy disclosed the following: (1) scirrhus carcinoma of the breast and (2) metastatic adenocarcinoma of the choroid, lungs, liver, pancreas and adrenal glands. Microscopic examination of the left eye showed slight edema of the iris and of the tissues at the filtration angle. On the temporal side of the section the choroid was thickened by infiltration with adenocarcinoma having a sclerosing stroma. There was some degeneration of the pigment epithelium of the retina, and a small amount of serous exudate between the retina and the choroid was present. The infiltration extended approximately to the equator and had advanced out along the sheath of the posterior ciliary artery. The right eye was essentially the same as the left.

DR. ERNEST F. KRUG, New York: I should like to add a few words to Dr. Cohen's report. That these cases are rare is true. In over twenty-

five years' clinical experience I have seen only 2 cases, and their similarity was marked; they were both in women under 40 years of age who had a history of primary involvement of the breast and eventually involvement of the lung. The patient in whom the condition developed the most recently is still alive. This case is particularly interesting since metastasis developed in the other eye. I removed the right eye in October 1936. The breast had been removed in 1934. The appearance of the mass in the right eye coincided with the recurrence in the amputation scar.

CAUSES OF SENILE CATARACT. DR. EDWARD JACKSON, Denver.

Certain causes of cataract are known, such as mechanical damage to the lens or diabetes. Other conditions are often suspected of causing cataract, and probably still others have not been considered in this connection. The term "senile" is appropriate because it gives a long period for many possible causes to operate. A comparison of experience should enable one to judge which of the suspected and unsuspected causes are probably responsible for the impairment of vision.

DISCUSSION

DR. C. A. CLAPP, Baltimore: I should like to ask Dr. Jackson one question. If the loss of water is the cause of the lenticular opacities, why is it that cataract does not develop in boiler inspectors, who are subject to high temperatures and who lose a large amount of water by perspiration but who are not exposed to light rays?

DR. EDWARD JACKSON, Denver: With reference to Dr. Clapp's question, I should say that further investigation on the subject is necessary.

I feel that there are not now enough facts to enable one to arrive at any conclusions. It may be that a cataract represents a deviation from normal nutrition in relatively recent structures. The human crystalline lens is definitely a more highly elaborated organ than the lens of any of the near lower animals, and it is entirely different from the lens of the invertebrate animals.

THE EYE AND DIABETES. DR. HANS BARKAN and DR. HORACE GRAY (by invitation), San Francisco.

The varied terminology used by ophthalmologists to designate abnormalities of the fundus in cases of diabetes is confusing to the internist who is treating the patient. On the basis of a clarified terminology, an attempt should be made to estimate from the enormously varying statistics in the literature the true probable frequency of the various ocular findings in patients with diabetes. Until comparable statistics on the results of treatment are available, one must depend on clinical impressions for the assessment of the value of any treatment as regards the eye in cases of diabetes.

DISCUSSION

DR. C. A. CLAPP, Baltimore: In discussing Dr. Barkan and Dr. Gray's paper, I should like to show a slide to illustrate the theory of

Waite and Beetham that retinitis starts first as a hemorrhagic condition. Retinitis is rarely found in the young. The condition shown here, in which there is no evidence of exudation, occurred in a youth aged 19. I feel that if persons with retinitis were observed in the early stages hemorrhages would be noted first and the exudation later. After these hemorrhages are seen, several years may elapse before exudation occurs. I believe that there is a definite diabetic retinitis, because one can make a tentative diagnosis of a diabetic condition in a person with retinal involvement before the general physical examination has been made, which usually corroborates the ophthalmic diagnosis.

DR. HANS BARKAN, San Francisco: In general, Dr. Gray and I have found that the statistics and the observations of Waite and Beetham and those of Braun and Mylius agree quite well with each other and seem to bear out certain points which we are presenting here. If one looks at the illustrations of diabetic retinitis in "Kurzes Handbuch der Ophthalmologie" one finds a plate illustrating diabetic retinitis which is an absurdity. It might as well be a picture of myelogenous leukemia or of bacterial endocarditis. It is not typical of the retinitis found in patients in the early stages of diabetes. We want to stress the point that there is such a picture and that one can tell in the majority of cases that one is dealing with diabetes primarily and not with arteriosclerosis or with hypertension associated with arteriosclerosis or with albuminuric retinitis.

DETACHMENT OF THE RETINA: OPERATIVE RESULTS IN ONE HUNDRED AND SIXTY-FOUR CASES. DR. JOHN H. DUNNINGTON and DR. JOHN P. MACNIE (by invitation), New York.

This paper was published in full in the October 1937 issue of the ARCHIVES, page 532.

ETIOLOGY OF IDIOPATHIC RETINAL DETACHMENT. DR. ALEXANDER E. MACDONALD, Toronto, Canada.

An explanation of the etiology of idiopathic retinal detachment based on hydrodynamic grounds is suggested.

DISCUSSION ON PAPERS BY DRS. DUNNINGTON AND MACNIE
AND DR. MACDONALD

DR. E. V. L. BROWN, Chicago: Acute edema as a cause of retinal detachment was the subject of an extensive paper by Krückmann at the 1936 meeting of the German Ophthalmological Society at Heidelberg. He elaborated on the mechanism, basing his remarks on a study of cases in youths aged 18, 20 and 25, respectively, who were carrying heavy loads when detachment occurred. They were bent over and going up a grade. In each case the load suddenly slipped, the head was thrown up from the lowered position, the eyes turned up further at the same time, and a pull on the inferior oblique muscles resulted. In each patient a detachment of the lower temporal quadrant of the retina was found the next day. Krückmann described the retinas as having the same ground-glass color as is seen in cases of Berlin's edema, namely, a peculiar milk-glass appearance. Krückmann asserted that when the eyes make a

sudden movement upward there is marked abduction of each eye. He expressed the belief that the lower temporal portion of the sclera is pulled away by the inferior oblique muscle from its position against the structures within the eye and that ischemia, and then edema, of the retinal vessels are produced. He also gave extended consideration to ischemia in relation to edema of the brain. He stated that his 3 cases of sudden retinal detachment which occurred while the patients were carrying heavy loads are unique, but the 5 cases reported here indicate that such cases may be frequent.

DR. LUTHER C. PETER, Philadelphia: To the ophthalmologist every phase of retinal separation is important. The patient, however, is interested in only one phase, and the questions which he naturally asks are: What are my prospects of recovery? How much vision will I have?

I believe that the prognosis should be made clear to the patient as to the possibility of reattachment, with the prevention of all the complications which follow retinal separation, and as to the possibility of restoration of central vision. Central vision, in my experience, is influenced (1) by the duration of the detachment and (2) by the proximity of the tear to the macula. This statement does not differ in any way from the report which Dr. Dunnington and Dr. Macnie made on this point, excepting as to the matter of time. I mean by this that a separation of three months' duration or longer is likely to leave some macular disturbance. As a matter of fact, retinal sensitivity, as has been pointed out, is reduced in practically every case, but macular vision may suffer, even in cases of recent detachment, although fairly good central vision can be obtained in those cases in which the detachment is of no longer than three months' duration. As has been pointed out, the prognosis in general is influenced to a large extent by the etiologic factors.

From the standpoint of surgery, although this phase of the subject has not been gone into in any detail, I believe there are three things which should be considered in conjunction with this comprehensive report. The first is the thoroughness of the preliminary study. It seems best to place the patient in the hospital for this purpose, even for a week before operation is attempted, during which time careful measurements can be made and recorded.

The second point is that of sealing the tear. I have found, in my later experience, that it is unnecessary to create many points of adhesion between the choroid and the retina; in other words, if the tear is surrounded by a proper number of needle punctures, which are carried out to the periphery and along the ora serrata, one can avoid a great deal of surgical trauma, which perhaps used to be more extensive than it is at present because the operator wanted to be sure to seal up every part of the retina that might cause a recurrence of the separation.

The last point which I feel is important is that of drainage. If the drainage is adequate and the tear has been properly sealed, the results should be good, and the percentage of good results will continue to increase. I am now using a small trephine, about 1.5 mm. in diameter, so as to be sure to obtain adequate drainage. It also reduces the number of perforations with the needle point, because one can use the Larssen

method to a considerable extent; this method is less damaging, and hemorrhages into the vitreous are naturally not so likely to occur.

DR. EDWARD N. DEWITT, Bridgeport, Conn.: Dr. Dunnington and Dr. Macnie are to be congratulated on the remarkable success they have had in replacing detached retinas. I have found four distinct types of retinal detachment with which poor results are obtained: (1) detachment of long standing, with many tears and low intra-ocular tension; (2) detachment associated with circulatory disturbances, such as essential or malignant hypertension and arteriosclerosis, and with multiple hemorrhages in the retina and papilledema; (3) detachment associated with nephrosclerosis and, to a lesser extent, with diabetes, and (4) detachment resulting from scar formation; that is, detachment resulting after removal of a foreign body from the retina months or years previously. Such detachments are due to contraction of scar tissue in the retina, and even if replaced by operation the retina again becomes detached a few months later.

DR. E. C. ELLETT, Memphis, Tenn.: I should like to ask Dr. Dunnington to discuss detachment of the retina in aphakic eyes.

It is comforting to hear the experience of others on eyes without retinal tears, but my impression is that the most satisfactory results have been obtained in eyes with accessible tears.

Gonin's early reports were too sketchy to enable one to understand his technic, and in my anxiety to do something I treated 2 patients with injections of mercuric cyanide, after the Surdille method. Both attempts resulted in failure. When I had learned more of Gonin's method, I procured a suitable cautery and did a number of cautery operations, with some success. The contact diathermy method of Larssen, in use at the time at Moorfields, appealed to me and is still my favorite method. For this method I use the Gradle needle, which partly perforates the sclera, and then surround the tear, if any, with Walker's micropins and trephine the sclera. In the meantime I tried Guist's potassium hydroxide method, but was not impressed by it.

My experience is not the same as that of Dr. Dunnington and Dr. Macnie, namely, that "the duration of the detachment had comparatively little effect on the operative result." I feel that recent detachments are the most amenable to operative procedure.

My total number of operations to date is between 50 and 60 on 48 patients. I have twice operated on a patient with unrecognized tumor of the choroid, and I can offset that experience by reporting cure of a detachment in a case in which tumor had previously been diagnosed. I have had several patients, indeed, a number, in whom an anatomic cure resulted; that is, the retina was replaced, but restoration of function was disappointing. The field of vision, but not the visual acuity, was fully restored. In some patients a macular lesion was seen, which most often appeared as a hole, but in others no definite cause for the poor vision could be found.

Since the prognosis of untreated retinal detachment remains almost 100 per cent unfavorable, I feel that every patient should be given the benefit of operation.

The arbitrary confinement to bed for one or two weeks in as near an immobile position as possible seems often unnecessary and at most is merely a guess at what is necessary. If the attempt to produce an

adhesive inflammation is successful, it would seem, judging from the behavior of other wounds not subjected to tension, that a shorter period of immobility would suffice, especially since the immobility is at best only relative.

DR. ARNOLD KNAPP, New York: I was particularly interested in a statement in Dr. Dunnington and Dr. Macnie's paper to the effect that their results in eyes without retinal holes, or their results with "blind" operations, were better than the results in eyes with retinal holes. I am sorry to say that my records do not bear this out. I have the detailed histories of 78 cases in which I have operated; holes were found in 68, varying in number from 1 to 12 in a single case. There were no holes in 10 cases. The results in these 78 cases consisted of cure in 53, or 68 per cent, and improvement in 6; if the results in these two groups are considered together, cure was obtained in 75 per cent. There were 19 cases, or 25 per cent, in which there was no improvement. The cases of aphakia have presented the greatest difficulty. I have had successful operative results in only 1 of 4 such cases. In the 3 in which operation accomplished nothing, no holes could be found. In the case in which operation was successful, a hole was found, which was closed.

I do not believe that it is so much the extent of the detachment as the size of the hole that is important; the giant holes in particular are difficult to treat. Those in the ora serrata do well. The cases in which holes have not been present have, in my experience, been cases of aphakia and of choroiditis.

It seems to me that one objection to blind coagulation is that too extensive damage is done to the eyeground. Not enough is known as to how much coagulation the eye will stand, but it surely is ideal if a hole is present simply to close it and then do a drainage puncture if the condition demands it.

The reason why the results in patients with low tension are poor is that the vitreous is disorganized or fluid. However, in some of these patients something can be accomplished by surface coagulation.

One great difficulty in operations for detachment remains—macular involvement. It is still not understood why, after a comparatively good result so far as replacing the retina is concerned, a macular change which impairs the visual result should develop.

DR. CLIFFORD B. WALKER, Los Angeles: I have been particularly interested in these two excellent papers. With regard to the occurrence of bilateral retinal detachment, as recorded by Dr. Dunnington and Dr. Macnie, I should like to ask whether in their series there were any instances of simultaneous bilateral detachment resulting from the same injury. None has appeared in 250 patients whom I have examined, although I know of an instance caused by the patient sitting down very hard on the floor when a chair was jerked from under him. In the literature these cases are few, almost rare.

Why does retinal separation occur, as a rule, in one eye only, although the injury often apparently shocks both eyes quite equally? Because of this fact it is usually argued that the retina which separates must have been degenerated more than the other, although the ophthalmoscope often does not confirm this. This may be true in some cases, but I do not believe that it accounts for the frequency with which tears occur in the upper temporal quadrant of the retina in the neigh-

borhood of the attachment of the superior oblique muscle. Here, at the top of the globe I believe, the retina is under additional mechanical disadvantage in the presence of the peculiar punishment of the powerful mechanism of pulley, long tendon-short contact arc.

To throw further suspicion on one superior oblique muscle, one must consider the conjugate positions of the eyes, wherein only one eye either is being acted on most strongly by its superior oblique muscle or stands in a position for decided or peculiar punishment by its superior oblique muscle. Furthermore, the long (19 mm.) tendon of the superior oblique muscle, after descending at an angle of 15 degrees, has its center of attachment from 3 to 4 mm. beyond the superior pole of the globe, where the sluggish weight of the ocular media helps a radical jerk on the sclera to produce a partial vacuum between the vitreous and the sclera. Diminishing waves of pressure and vacuum may follow the jerk, but this type of punishment is just the sort to cause a cystically degenerated or otherwise weakened area to form the original tiny hole that leads to the formation of a tear. The natural lack of contact arc of the superior oblique muscle is ameliorated less and less by the overlapping superior rectus muscle as the eye turns downward and outward.

Although the superior rectus muscle is relaxed as the eye turns downward, and uncovers the superior oblique tendon more and more as the eye turns outward, still it smothers most of the radial or centrifugal component of the pull of the superior oblique muscle during the first 15 or 20 degrees (fixation) of scleral movement toward the pulley. My measurements, models and diagrams show that the pulley center is about 20.5 degrees away from a point 1.25 mm. back of the center of the eye. If the center point of attachment of the superior oblique muscle is moved 13.25 mm. by rotation (looking downward and outward) until it reaches the 20.5 mm. line, the pull of the superior oblique muscle becomes largely radial or lifting on the sclera in spite of the relaxed superior rectus muscle. At 9.5 mm. of rotation (45 degrees of fixation downward and outward) the superior oblique muscle would have to lift only the nearest border of the limp superior rectus muscle about 2.5 mm. more than in an ordinary rotation in order to develop a lifting centrifugal component to the sclera of about two thirds of its total pull at that time.

An added stimulus while the eyes are at, or half-way toward, this critical conjugate position could, I believe, damage only the retina of the eye of the side to which the gaze was directed, even though both fourth nerves were equally affected by such injuries to the spine, cranium or body as could produce longitudinal transmission to the mesencephalic region. If other nerves were stimulated at the same time, tending to jerk the eyes back into normal position or farther, while the eyes were still being held in conjugate deviation, the action of opponents could give a similar result by jerking the *eye away* from the still taut and tethering superior oblique tendon.

This explanation is the most satisfactory one I can give to account for the "one side only" phenomenon, if it is possible for the stimulations to originate in some such manner as stipulated. Certainly an ocular muscle is strong enough (from 500 to 1,000 Gm. pull) to give the sclera a vicious jerk.

The softer the eye, the more effective this mechanism can be. I therefore advise and urge all patients with low ocular tension to wear pupil goggles and avoid hazards carefully if they really wish to protect their vision. I am especially insistent on this in cases of aphakia before and after operation. Detachment of the retina in cases of aphakia is so hard to cure that I believe more "cures" will really be obtained with strict enforcement of "pupil goggle prevention" the first year after operation, if tension is low, than with the present methods of surgical treatment. The postoperative aphakic eye continues to gain in strength for more than a year. Many patients will not be treated for a whole year, but I am sure that every possible immobilization treatment is helpful, in spite of the fact that in this matter Vogt does not follow Lindner, to whom credit is due for pupil goggles.

In separations primary in the lower part of the retina, without a visible tear, as analyzed by Dr. MacDonald, it must be remembered that an invisible single broken cyst in the periphery can give rise to a separation similar to a pinhole in a tire, and yet the tear may remain small and hidden because the weight of the vitreous inhibits such mechanics as occur in the upper polar region and the inferior oblique muscle has no such punishing ability as the superior oblique muscle. Krückmann's complicated analysis of the mechanism of retinal detachment, as pointed out by Dr. Brown, must also be considered in this connection. Further, the phylogenetic youth and weakness of the inferior portion of the retina and macula must not be ignored. In general, on the basis of my experience I believe that detachments in the lower portion of the retina, with or without visible central or peripheral holes, are quite amenable to treatment in persons up to 40 years of age with or without myopia.

DR. EUGENE M. BLAKE, New Haven, Conn.: Dr. MacDonald's paper is interesting and proves that detachment can occur as a result of lifting heavy weights. It gives one something to refer to. A year ago I saw a man of 29, whose occupation involved the lifting of heavy bundles of paper, in whom detachment of the retina occurred. The question arose as to whether or not this injury was compensable. It seemed to me reasonable to attribute the detachment to his occupation. Operation resulted in complete reattachment.

DR. SANFORD R. GIFFORD, Chicago: No attention has been called to cases in which a hole occurs in the upper portion of the retina while the detachment occurs in the lower portion. I have seen a number of cases in which this occurred; such cases seem to prove the effect of the tear in the production of detachment more than anything else. In the first case in which I recall operating I was afraid not to cauterize below, so I cauterized in the region of the hole and below and obtained a good result, but in 2 later cases I did not do anything below the hole except trephination. I cauterized in the region of the hole and was able to close it, but I did nothing below the hole except to let the fluid out. Such cases are common and are responsible for some of the reports in which it is stated that holes were not found.

I wish to call attention to the value of the Friedenwald ophthalmoscope in discovering holes. I have found in cases in which one hole was discovered with the ordinary ophthalmoscope with very good light

that four or five holes could be found with the fine beam of the Friedenwald ophthalmoscope. Also, in certain cases in which holes are suspected the fine beam enables one to decide whether or not the hole is complete, as one can see the edges so entirely that there can be no doubt about it.

DR. JOHN H. DUNNINGTON: There are a few points which I should like to add. Trephining to insure free drainage of the subretinal fluid was used in a considerable number of these cases, but a study of these did not lead to any conclusion as to its efficacy. It seemed to us that sufficient drainage was obtained from the punctures made with the Walker needles or with the electrodiaphake of Lacarrère.

I cannot answer Dr. Ellett's question as to why the prognosis is so unfavorable in the cases of aphakia. The study of 13 cases did not lead us to any definite conclusion along this line. In those cases of retinal detachment associated with aphakia, the latter was present before the detachment had its onset.

We do not wish to give the impression that the duration of the detachment is of no importance, but we hoped rather to encourage treatment in cases of long standing.

I also cannot answer Dr. Ellett's question regarding the length of the period of confinement in bed; i. e., whether it is necessary to keep the patient there as long as most ophthalmologists do. I really believe that he is correct and that it would be safe to let the patient up much earlier, but we have followed the usual teaching.

In regard to the incidence of bilateral detachment which Dr. Walker spoke of, I am afraid that we did not make ourselves clear. In the paper we simply mentioned that detachment of both eyes occurred in 6 per cent of the cases. We did not mean that they had occurred simultaneously, for often a period of several years elapsed between the detachment in one eye and that in the other. Our only reason for mentioning it was to call attention to the frequency with which bilateral detachment does occur, in the hope that this knowledge might serve as an additional stimulus to all ophthalmologists to conserve all possible vision in every case of retinal detachment.

DR. ALEXANDER E. MACDONALD: I wish to thank Dr. Brown and Dr. Walker for calling my attention to Krückmann's paper. I did not know of it previously. I must say that I am not particularly impressed by the possibility of the action of the oblique muscles causing detachment. It seems to me that the synkinesis of voluntary movement is not so rapid as one finds in nystagmus or in nystagmoid jerking, and I am not aware of any case in which detachment of the retina is associated with these conditions.

If my work is confirmed, it is important to pay attention to the after-treatment of retinal detachment. Patients should avoid all lifting strain, and even bending down should be done with care.

I wish to call attention to the high levels of cerebrospinal fluid pressure that may be found in metabolic diseases. If such cases are followed more carefully, a definite relationship may be found; that is, the intensity of the retinal changes may go hand in hand with the level of the cerebrospinal fluid pressure.

NEUROMYELITIS OPTICA: A REPORT OF TWO CASES. DR. HANFORD MCKEE and DR. FRANCIS MCNAUGHTON (by invitation), Montreal, Canada.

The first clinicopathologic studies made on neuromyelitis optica by Achard and Guinon in 1889 and the later studies made by Devic in 1894 are cited. Since 1894 the condition has been referred to as Devic's syndrome. The striking symptoms observed in 2 typical cases seen at the Montreal General Hospital are described.

DISCUSSION

DR. SANFORD R. GIFFORD, Chicago: I should like to place on record 2 cases which I consider to belong definitely to this syndrome, and 1 case which I believe is of similar nature. Of the first 2 cases, 1 was reported by Dr. Perritt from the Cook County Hospital in 1934, at which time he mentioned the other case. This condition is so dramatic that it could never be overlooked if a typical case of it has been seen before.

The first case was that of a boy of 12 years. When I saw him the disk was elevated 6 diopters, and there was no light perception in the affected eye. The other eye was normal. The boy was perfectly healthy. In this case one could think only of a tumor in the optic nerve. The condition was not diagnosed. Two weeks after I saw him, he fell while walking and was taken to the hospital, where a diagnosis of transverse myelitis was made. During his stay in the hospital the vision in the other eye decreased to perception of hand movements; no change in the disk was observed at any time. In the eye first affected typical optic neuritis was present; in the second eye there was retrobulbar neuritis. In two months the condition had gradually cleared up, and two months later the vision was 20/20 in each eye. The nerve of the first eye was pale and showed changes resembling secondary atrophy, but vision was normal. In the other eye there was a slight pallor of the disk.

The second case, reported by Perritt, was that of a girl of 5 years. In this case myelitis had preceded optic neuritis. The child had had measles three or four weeks before, with paralysis of one leg. One day when she awakened she could see nothing with either eye. She was brought to the hospital, and mild optic neuritis was found in one eye. There was no light perception in either eye. The condition cleared up later, and she left for another city; reports from there showed vision of 20/20 in one eye and 20/40 in the other. Examination of spinal fluid showed 97 cells per cubic millimeter.

Recently Dr. Lawson, of Evanston, Ill., and I observed a girl aged 9 years whose symptoms were confined to a sudden loss of vision first in one eye and then in the other. There was mild optic neuritis in both eyes, and the vision was 5/200 in each eye, with a large central scotoma. Spinal puncture and neurologic examination gave negative results. No myelitis was present, and vision has returned practically to normal. Dr. Lawson has not mentioned any elevation of the disks at the present time.

An interesting question has been raised as to whether the changes of multiple sclerosis will develop later in these cases, because changes occurred in a few weeks which in cases of multiple sclerosis occur during the course of years, and it has been suggested that these represent an

acute form of sclerosis. I do not know of any cases in which the patients have been followed long enough to determine whether later signs of multiple sclerosis will develop.

DR. ALAN C. WOODS, Baltimore: I have been so unfortunate as to see a number of cases of neuromyelitis optica and cases of Schilder's disease, encephalitis periaxialis diffusa, all of which constitute apparently the same pathologic condition—an acute demyelinating disease with different clinical syndromes. As Dr. Gifford and Drs. McKee and McNaughton have emphasized, at the onset these conditions are often quite similar. The ocular symptoms predominate, and there may be great confusion as to the exact diagnosis, which becomes evident only with the later development of the myelitis. Owing to the early diagnostic uncertainty, 3 of these patients were subjected to operative procedures—1 to an exploratory craniotomy, 1 to an injection of the ventricles with air and 1 to the opening of the posterior nasal sinuses. The ultimate visual outcome in all these patients was bad. Those patients not operated on and not subjected to a lumbar puncture made remarkable recoveries. In these dramatic cases it seems to me that any operative or traumatizing procedure, even a lumbar puncture, is contraindicated.

THE POSSIBILITY OF MÖLLER'S MUSCLE ACTING AS AN OPPONENT. DR. CLIFFORD B. WALKER, Los Angeles.

After construction of a large model of the orbit, with the eyeball and extra-ocular muscles in the primary position, it has been demonstrated that a resultant force from these muscles could be active, at least by tonicity, tending to pull the eye toward the nasal wall. Müller's muscle, fortifying strongly developed layers of Tenon's capsule, is considered from the functional standpoint of oppositional action to such a nasal resultant rather than as a purely vestigial remnant.

DIVERGENCE INSUFFICIENCY: A CLINICAL STUDY. DR. AVERY D. PRANGEN and DR. FERDINAND KOCH (by invitation), Rochester, Minn.

Divergence insufficiency is characterized by esophoria in both distant and near vision; esophoria is greater in distant vision. Abduction is persistently below normal, and homonymous diplopia is elicited easily on fatigue or on breaking up of binocular fixation. Although the anomaly is one of divergence, symptoms are more marked in near vision. The condition occurs in tense persons who are engaged in the types of higher occupation which require much close work. Treatment by means of a full balanced correction of the existing ametropia and anisometropia, together with prism base out, is suggested. An early or even premature correction for presbyopia also seems to be of benefit.

DISCUSSION

DR. JAMES WATSON WHITE, New York: I have not found, as Dr. Prangen has, that the symptoms of divergence insufficiency are more marked at the near point; rather the panorama asthenopia and double vision are much more annoying for distant vision. There is always an

esophoria or esotropia for distant vision, but at 33 cm. there may be only a trace of esophoria. Frequently there is an exophoria at 25 to 30 cm., and at 20 cm. there is practically always an exophoria. The convergence near point is rarely excessive and is more likely to be remote. The esophoria or esotropia, as well as the diplopia for distant vision grows progressively less as the light approaches the eyes, and both disappear at some point within 1 meter, depending on the amount of the deviation. It is an interesting observation, although usually not necessary to a diagnosis, to measure the amount of the esophoria and also of the diplopia, at 6 meters, 3 meters, 1 meter, 0.5 meter and 0.25 meter. In doubtful cases the deviation for distant vision should be measured at 25 to 50 meters also. The test for diplopia is not so dependable as the actual measurement of the amount of deviation by the screen test.

I have found, as Dr. Prangen has, that there is some degree of hypocyclusis for which a plus lens must be added for reading. This plus lens, however, does not reduce the esophoria for distant vision if the esophoria is due to a divergence insufficiency. However, if the esophoria is due to a convergence excess, the esophoria for near vision is definitely lessened. If the esophoria is about the same for distant as for near vision and if atropine or plus lenses will definitely reduce it, the condition is probably a convergence excess; but if the esophoria for near vision is considerably reduced, or if it is changed to an exophoria, and the esophoria for distant vision is practically unchanged, then a primary divergence insufficiency probably exists.

It is possible that some of the patients observed by Dr. Prangen primarily had convergence excess. This would seem probable, since the symptoms for near vision instead of for distant vision were so much increased, as in a typical divergence insufficiency.

Prism divergence for distant vision is below normal and may be nil, whereas for near vision the prism divergence may be quite normal. I have not found a prism divergence of as much as 3 to 4 diopters, as Dr. Prangen has.

Prisms base out in glasses for distant vision are well borne, but if these glasses are used for close work the symptoms may increase. The prisms in the reading correction tend to act as a prism convergence exercise and to increase the esophoria for near vision. This is proved by the fact that if the patient is using prisms base out when first seen, removal of the prisms will not change the esophoria for distant vision, whereas the esophoria for near vision will be definitely lessened.

No form of divergence exercises has been of any aid in my cases of divergence insufficiency. However, if the condition is one of convergence excess, divergence exercises are a definite aid. I have not found the high incidence of nervous symptoms and constitutional conditions which Dr. Prangen has found.

DR. THOMAS D. ALLEN, Chicago: I think one of the tests which Dr. Prangen did not have time to speak about should be emphasized, and that is the test of the patient's ability to fuse. If a person obviously has no ability to fuse, prisms will do no good. Occasionally prisms may be of some use when there is weak fusional ability. I usually test for stereopsis and I presume Dr. Prangen always does. I find when I am a little hesitant about fitting prisms that it is of great value to put into a

lightweight frame the glasses that I believe should be used and then to add or subtract the prisms and let the patient wear the glasses for a half-hour or longer in the office.

RELATIONSHIP OF HETEROPHORIA TO DIVERGENCE AND CONVERGENCE
BASED ON CLINICAL MEASUREMENTS. DR. F. H. HAESSLER,
Milwaukee.

An attempt is made to help elucidate one of the fundamental concepts of heterophoria; namely, how it is related to the functions of convergence and divergence. For this purpose, clinical measurements of heterophoria, convergence and divergence on 1,000 patients were analyzed and presented.

SURGICAL MANAGEMENT OF PTOSIS, WITH SPECIAL REFERENCE TO
THE USE OF THE SUPERIOR RECTUS MUSCLE. DR. P. CHALMERS
JAMESON, Brooklyn.

This paper was published in full in the October 1937 issue of the ARCHIVES, page 547.

DISCUSSION

DR. SANFORD R. GIFFORD, Chicago: I wish to mention another operation for ptosis, the value of which I have discovered in the last two years, and that is the Blaskovics operation, as modified by Lindner. I want to show the typical results of this operation in 2 cases.

The first case was one of typical bilateral ptosis. The Blaskovics operation is a resection of the levator muscle. I did not perform this for a long time because I did not believe it applicable to cases of complete ptosis until Lindner showed that it was. By resecting the tarsus and making the advancement of the muscular tissue, which is always present if it has no apparent innervation, good results are obtained, even in cases of complete ptosis.

The second case was that of a girl with almost complete unilateral ptosis. I noticed nothing peculiar about this, except that she had 20 degrees of right hypotropia. I performed a Blaskovics operation, and she returned satisfied with the result. However, she told me that her parents had observed that when she was eating the lid operated on opened more widely than did the lid of the other eye. I found that she had a Marcus Gunn phenomenon. Here was a patient whose ptosis was so marked that I did not see the Marcus Gunn phenomenon, but after the operation it was obvious that on biting down while eating she raised the lid about twice as high as the other lid; when she was not biting down, she looked quite well. The operation requires time, but if it is done according to Lindner's illustrations, which the operator should have before him the first time he attempts the operation, it is a satisfactory procedure, even in cases of practically complete ptosis with paralysis of the superior rectus muscle in which the Motais operation is not indicated.

DR. CONRAD BERENS, New York: During the past two years, at the New York Eye and Ear Infirmary a procedure somewhat similar to Dr. Jameson's (suggested by George Young) has been employed in which the entire superior rectus muscle is used. Young suggested drawing the

muscle down, as advised by Dr. Jameson. He then inserted three double-armed sutures in the muscle, passing these through the upper eyelid after excising a piece of the upper border of the tarsus.

DR. P. CHALMERS JAMESON, Brooklyn: I believe that there is no single operation that is suitable for every case of ptosis. I like to divide the cases into those in which the "heavy burden operations" should be done and those in which the degree of ptosis is slight. I have mentioned some of the operations which can be used to correct lesser degrees of ptosis. I believe that my operation, so far as the superior rectus muscle is concerned, can be used to give motion, but often one of what I term the "heavy burden operations," such as the Eversbusch procedure, is needed to supplement the operation in order to obtain the best results.

There is one thing I should like to emphasize, and that is gradation. Little has been said about gradation in operations for ptosis, and I think that it is essential. An ocular muscle is strengthened by shortening it, but often no attempt is made to strengthen the superior rectus muscle sufficiently to bear the additional burden of a heavy lid in the same way. I think that this can be done to great advantage. It is not fair to expect an attenuated passive muscle like the superior rectus muscle to assume a load four or five times greater than it is able to carry, and that accounts for failure in so many of these operations on the superior rectus muscle. A combination of procedures should often be used. The operation on the superior rectus muscle will give motion, but it will give no independent motion to the lid.

TRANSLATION OF TENON'S CAPSULE IN OPERATIONS ON THE OCULAR MUSCLES, WITH ESPECIAL REFERENCE TO POSTOPERATIVE DEVIATIONS WITH ADHESIONS BETWEEN THE MUSCLES AND THE EYEBALL. DR. CONRAD BERENS, New York.

A piece of Tenon's capsule is reversed and sewed to the episcleral tissue beneath the muscle. The results of the operation in 3 patients seem to have been satisfactory.

DISCUSSION

DR. JOSEPH M. KEELER, St. Louis: Dr. Berens speaks of reversing a piece of Tenon's capsule. I wonder whether he has ever tried to free the capsule at one side and then slide it under the muscle, in the hope of preventing the reformation of adhesions.

DR. P. CHALMERS JAMESON, Brooklyn: I believe that Dr. Beren's procedure is quite feasible and should be tried. Of course, one of the controversies which is frequently advanced concerning shortening and advancement is that action is obtained only from the most posterior adhesions. If this operative procedure will substitute a normal under-grounding between the muscle and the eyeball, it would enable one to secure the full effect and correction from the point of insertion of the muscle. As a matter of fact, I think that the posterior adhesion theory has been overexaggerated. If one adheres to this strictly, in virtually every operation that is performed on an ocular muscle the muscle is advanced or receded to the equator. A disadvantage of this procedure might be that the insertion of a sector of capsule under the muscle might provide no better gliding base than is usually left after a recession

or advancement, as the capsule, muscle and sclera in the freshened state would firmly agglutinate. The dissection and placement of the capsule would then be both harmful and unnecessary.

One of the objections to the Worth operation, as stated by the advocates of shortening, is that one does not obtain any more effect from this procedure by reason of the muscle acting from its posterior adhesion. Of course, transplantation of Tenon's capsule is not likely to be as readily applicable in cases in which there are adhesions anterior to the insertion of the muscle, but if it should be, it would overcome the foregoing objection.

DR. CONRAD BERENS, New York: Dr. Keller's question as to whether one could not slide Tenon's capsule beneath the muscle also suggested itself to me. I employed advancement and lateral displacement of Tenon's capsule recently on a child with exotropia who had previously been operated on and who had a stitch abscess involving the medial rectus muscle. In cutting into the tissues I found the muscle to be decidedly atrophic, and there was extensive fibrosis. The part of the muscle that was fibrosed and adherent to the sclera 15 mm. from the cornea was excised. Tenon's capsule was found to be greatly thickened beneath the muscle, where it assumed an oblique angle. Since the capsule was so thick and was not adherent to the muscle in this position, the piece of the capsule was brought forward instead of being excised. This patient is not presented here because the operation was performed only a week ago. At present the eye continues to diverge.

Dr. Jameson's question in regard to where the muscle pull is exerted is an important point. I have always believed that resection produced almost as good results as advancement because of the adhesions to the old insertion. However, this would be extremely difficult to prove. I believe that it may vary according to the degree of fibrosis of the muscle and the extent of the adhesions. Adhesions were found between the muscle and the eyeball as far back as 20 mm. in 2 cases and 15 mm. in 1 case. Other methods of attempting to correct the deviations had been employed, with unsuccessful results.

In reply to my inquiry as to whether he had employed this operation, Dr. Peter asked if I would not produce more adhesions with Tenon's capsule, and whether I would have difficulty with these adhesions, thereby limiting the effect of the operation. It is possible that some undesired effect may be produced. However, in 2 patients this defect, as well as the tendency for the reformation of adhesions between the muscle and the sclera, was apparently overcome.

In 1 patient only 4 diopters of hypertropia was found before operation, and the postoperative studies revealed 14 diopters. This vertical deviation might possibly be the result of traction by scar tissue following the excision of Tenon's capsule.

THE MECHANISM OF THE FORMATION OF THE AQUEOUS. DR. JONAS S. FRIEDENWALD and DR. ROBERT D. STIEHLER (by invitation), Baltimore.

Previous studies have shown that the ciliary body exhibits an reciprocal permeability to water and methylene blue. The present study represents an attempt to discover the physical basis for this mechanism.

It is found that there is a semipermeable, electrically charged membrane between the stroma and the epithelium of the ciliary body. This membrane is permeable to neutral and acid dyes and impermeable to basic dyes. The ciliary stroma is capable of reducing methylene blue and thus converting it to neutral substance, while the ciliary epithelium oxidizes reduced methylene blue. The energy for the irreciprocal permeability of the ciliary body is derived from the difference in oxidation reduction potential between the ciliary stroma and the epithelium. It is postulated that water is transferred across the membrane by electro-endosmosis.

DISCUSSION

DR. F. H. VERHOEFF, Boston: I should like to ask Dr. Friedenwald and Dr. Stiehler if similar experiments have been made on the conjunctiva.

DR. JONAS S. FRIEDENWALD, Baltimore: We have no experiments on the permeability of the conjunctiva to report. There is, however, already some evidence in the literature that the cornea possesses irreciprocal permeability. This has been demonstrated by F. P. Fischer, but the mechanism in regard to the cornea has not been interpreted.

OCULAR CHANGES EXPERIMENTALLY PRODUCED IN THYROPARATHYROIDECTOMIZED DOGS, WITH SPECIAL REFERENCE TO INTRA-OCULAR TENSION AND BLOOD PRESSURE: A PRELIMINARY REPORT. DR. GRADY E. CLAY and DR. J. MASON BAIRD (by invitation), Atlanta, Ga.

In all animal experimentation on the thyroid and parathyroid glands, no mention has been made of the state of the intra-ocular tension and blood pressure.

Ten years ago patients were seen who had a low tension (below 13 mm. Schiötz) without any other ocular pathologic process. In many of these patients opacities of the vitreous, and later posterior sub-cortical lenticular changes, developed. In 2 patients detachment of the retinas developed. A study of these patients (to be reported later) showed them to have a low basal metabolic rate and low blood pressure, which was not in direct proportion to the intra-ocular tension, and no patient presented symptoms of myxedema. The authors, therefore, feel that there is an essential hypotensive ocular disease which is of as much importance as the much studied hypertensive disease, glaucoma. These clinical findings led to a study of thyroparathyroidectomized rabbits and dogs, which was begun in 1929.

At the time 10 rabbits were studied following parathyroidectomy; 5 rabbits survived long enough for a daily study of the intra-ocular tension, and all showed a drop of 10 mm. or more. Since 1933 60 dogs have been used, and on 47 of these the basal metabolic rate, the blood pressure, the calcium content of the blood and aqueous, the intra-ocular tension and changes in the vitreous and lens have been minutely studied. The animals showed a marked decrease in the calcium content of the blood after operation, with a tendency to an increase as they came under dietary control. With the administration of parathyroid extract, the rise was accentuated but did not reach a normal level. Study of the aqueous had given indeterminate results with certain significant figures.

It will be shown that a sudden and constant drop in the intra-ocular tension occurred in all dogs. Coincident with this there was a lowering of the blood pressure, but it was not as great in proportion as that of the intra-ocular tension.

Dogs kept on a sustaining calcium diet, and especially those given parathyroid extract, had a definite increase in blood pressure and basal metabolic rate. During tetany, both the blood pressure and the intra-ocular tension increased.

Opacities of the vitreous developed in the dogs having a hypotension of four weeks' duration, and in such dogs lenticular opacities are much more likely to develop. These opacities usually begin to appear after from two to three months, the suture lines showing the earliest involvement.

Thyroparathyroidectomized dogs which were fed thyroid extract showed no increase in the intra-ocular tension, and animals with most of the thyroid and one pair of parathyroid glands removed did not show such a marked decrease in intra-ocular tension.

Intra-ocular hypotension is produced in dogs by thyroparathyroidectomy. The parathyroid glands seem to be the chief causative factor for this phenomenon. It is thought that the lowering of aqueous volume or aqueous stasis is responsible for the opacities of the vitreous and the development of this type of cataract. This may explain cases of idiopathic detachment of the retina.

DISCUSSION

DR. JONAS S. FRIEDENWALD, Baltimore: I should like to ask what pupillary reactions occurred in these animals, and whether the authors are sure that the cervical sympathetic nerves were not injured.

DR. GRADY E. CLAY, Atlanta, Ga.: In answer to Dr. Friedenwald's question, no careful study of the pupillary reflexes was made until within the past few weeks, and observations on 5 dogs showed that there was no disturbance of their pupillary reflexes. We therefore felt that there was no disturbance of the cervical sympathetic system to explain the lowering of the intra-ocular tension.

BIRTH INJURIES OF THE CORNEA AND ALLIED CONDITIONS. DR. RALPH I. LLOYD, Brooklyn.

The typical injury of the cornea at birth is the result of compression of the globe against the roof of the orbit by the end of the forceps blade. After all of the acute changes have cleared, the signs of such an injury in a typical case are a high degree of amblyopia, a corneal scar, tears in Descemet's membrane and, after some time, keratoglobus. The damage to Descemet's membrane is most common and permanent and consists of either a series of concentric or parallel tears or a complete stripping of this membrane from the substantia propria. In the latter case there are also lacerations which separate the detached membrane into broad strips that run from attachments near the periphery across the anterior chamber free in the aqueous like the string of a bow.

This highly elastic tissue also rolls up from each lateral margin, converting each strip into a rod, which is almost transparent. This is one type of so-called "glass membrane in the anterior chamber." In

cases of long continued or active keratitis, folds appear in Descemet's membrane, and fibrin collects along these on the posterior surface of the cornea, forming another type of glass membrane. This type occurs most frequently in cases of interstitial keratitis.

During the course of sharp tuberculous iridocyclitis, another type of glass membrane is formed. Its appearance suggests that it is a defense mechanism for the protection of the cornea from the damaging effects of the deposits constantly thrown against this surface during the course of such inflammations and that they are really vascular in nature. The name of "posterior pannus" has been suggested for this type of glass membrane. The peculiar form of some of the glass membranes which develop in cases of interstitial keratitis is much like some of the remnants of the persistent pupillary membrane attached to the posterior surface of the cornea.

DISCUSSION

DR. THEODORE L. TERRY, Boston: In 1926, before the Ophthalmological Society of the United Kingdom, Ballantyne reported a case of detachment of Descemet's membrane resulting from a birth injury inflicted by forceps. He was able to examine the eye again when the child was 5 years of age. By oblique illumination he found a somewhat crescentic figure in the upper portion of the cornea. The upper line was somewhat serrated, whereas the lower line formed a gentle curve. With the slit lamp he discovered an apron-like detachment of Descemet's membrane, the upper wavy line being the base and the lower curved line being the free edge. In the beam of the slit lamp at the lower edge of the detachment there was a bright, expanded bead. The shape of this detachment no doubt prevented extensive rolling up of Descemet's membrane into a rod, as Dr. Lloyd has observed.

At the laboratory of the Massachusetts Eye and Ear Infirmary there are sections of just such an eye. The original central core of Descemet's membrane hangs down into the anterior chamber, on which there are several newly deposited layers of this membrane. Since the free edge of the membrane has rolled somewhat, the newly formed Descemet's membrane covers over this roll, producing a nodular extremity. Such an extremity would give the appearance of a bright bead in the beam of the slit lamp. Presumably, the layers of the newly formed Descemet's membrane are due to repeated loss and regrowth of endothelium. This patient noticed slight irritation and redness of the eye at the age of 21. She consulted Dr. Verhoeff, who observed recurring attacks of bullous keratitis. There was no history of birth injury or trauma to the eye. Finally, glaucoma developed, and since the vision had always been poor, the eye was removed.

CYCLOPLEGIA WITH BENZEDRINE AND HOMATROPINE: PRELIMINARY REPORT. DR. S. JUDD BEACH and DR. W. R. McADAMS (by invitation), Portland, Me.

The work of Myerson, showing the synergistic action of atropine and benzedrine so that minimal doses control the ciliary action, suggested the possibility of combining benzedrine with homatropine for the same purpose. In a series of adults it was found that cycloplegia followed in one hour after a single instillation of benzedrine and homatropine.

Ability to read returned in many cases as early as six hours after the instillation. By using the new combination in one eye and homatropine alone in the other eye, it has been possible to compare the efficiency. The added safety of the transitory mydriasis is obvious.

DISCUSSION

DR. ALAN C. WOODS, Baltimore: I should like to ask Dr. Beach and Dr. McAdams if any further observations have been made on the same eye on the amount of cycloplegia obtained with a combination of benzedrine and homatropine and later on the amount of cycloplegia obtained by the use of atropine.

DR. C. A. CLAPP, Baltimore: I should like to inquire whether any patients have shown an idiosyncrasy to this drug.

DR. PARKER HEATH, Detroit: Were any changes in the intra-ocular pressure noted?

DR. S. JUDD BEACH, Portland, Me.: Our observations are not yet complete enough to give satisfactory answers to most of these questions. As Dr. Woods suggests, we have used the two drugs separately at different intervals, but we have no data on this point worth considering. We have not yet encountered any idiosyncrasies.

INTRA-OCULAR INVASION BY THE LARVA OF THE ASCARIS: REPORT OF A CASE WITH UNUSUAL COMPLICATIONS. DR. F. PHINIZY CALHOUN, Atlanta.

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TREATMENT OF OCULAR TUBERCULOSIS. DR. ALAN C. WOODS and DR. M. ELLIOTT RANDOLPH (by invitation), Baltimore.

This paper was published in full in the October 1937 issue of the ARCHIVES, page 510.

DISCUSSION

DR. FRANCIS H. ADLER, Philadelphia: I should like to ask Dr. Woods and Dr. Randolph if they have any data that show a correlation between the clinical improvement in their patients and the loss of cutaneous sensitivity. I am in accord with the theory that allergy and immunity are two separate factors, and on that basis the patient who shows a marked cutaneous sensitivity should also show some correlation between his clinical improvement and the loss of cutaneous sensitivity after a course of treatment with tuberculin. Unfortunately, in my hands at least, I have been disappointed in that they do not seem to go hand in hand. The patient who has a marked cutaneous sensitivity is not always the one who does best with tuberculin therapy. Sometimes the patient who has a low cutaneous sensitivity is the one who shows most marked improvement, and, furthermore, when clinical improvement occurs after a course of tuberculin, the patient who has a high cutaneous sensitivity still maintains it.

I believe that every ophthalmologist should use some standardized technic in his cases. There is now a standardized purified derivative of

tuberculin which can be used for testing cutaneous sensitivity. Often the figures in the literature are confusing, largely because of different tuberculins which have been used, but every one can use this purified protein derivative and obtain results which should be uniform.

DR. F. H. VERHOEFF, Boston: As I understand it, Dr. Woods and Dr. Randolph have taken a series of cases of ocular tuberculosis of various kinds—hardly any two cases can be compared with each other, since they are so different—and have treated one group of patients with tuberculin by one method and another group by another method, but I do not understand that they have a control group to whom tuberculin was not given. For the sake of argument, if I should say that their results simply show that one of the methods of treatment with tuberculin made the patients a little worse than if tuberculin had not been used and that the other method made them even more worse, how could they deny this? My impression is that a control series of patients to whom tuberculin is not administered gives a good set of results. Moreover, if one has a large control series and divides the patients indiscriminately into two groups, I am sure that the results in each group will differ considerably. I am simply pointing out how difficult it is to draw conclusions from statistics, especially when one is dealing with cases that are individually so different.

DR. ARNOLD KNAPP, New York: I belong to the group that believes that tuberculin therapy helps ocular conditions. If I understood correctly, Dr. Woods and Dr. Randolph have undertaken treatment with tuberculin along two lines: first, by using increasing doses and, second, by using the small doses over a long period. I should like to ask how they differentiate the cases before administering treatment—what type of ocular tuberculosis requires which of these two forms of treatment? I have carried out both types of treatments, and both have given good results. The second, or the one in which an "optimum" dose is used, has given the best results, which agrees with Dr. Woods and Dr. Randolph's experience. In using the latter method, I have been much pleased with the use of A O tuberculin.

I was particularly interested in hearing the report on the beta ray radium, and I hope that Dr. Woods will go into particulars a little more fully in his closing remarks.

DR. E. V. L. BROWN, Chicago: I sympathize with Dr. Verhoeff's side of this question. I should like to see more series of patients who are not treated, because the disease tends to be self-limited.

I want to refer to a series of 4 cases that I reported in St. Louis last year and that were later reported in the *American Journal of Ophthalmology*. In these there was a parallelism between the tuberculosis of the anterior segment and the definite findings in the chest. The condition was of marked severity in each case. From 10 to 12 nodes were present in each iris, and these left Michel flecks in the irides after the nodes were absorbed; the keratitis consisted of a glomerular-form arrangement of vessels, with deep nodes in the cornea. Treatment with tuberculin was not effective. All the patients were cured by thorough rest. I believe that there is a growing number of cases in which there is a parallelism between the nature and the severity of the findings in the chest and those in the eye. I have had another case this year in which a massive

nodular tuberculosis of the iris was present. There were no lesions in the chest for many months, but in the past two months there has been a marked development of pulmonary lesions.

DR. ALAN C. WOODS, Baltimore: Dr. Adler has put his finger on the crux of the question so far as sensitivity in ocular tuberculosis is concerned. There is no exact information on the relation of ocular sensitivity to cutaneous sensitivity. In ocular tuberculosis one is chiefly concerned with the question of the sensitivity of the eye. We have no means of testing this, and we therefore test the cutaneous sensitivity on the theory that cutaneous and ocular sensitivity may run parallel. For the past year this question has been under active investigation in the Wilmer Institute. Our experiments, the first of which will soon be reported, indicate that under normal conditions cutaneous and ocular sensitivity may run parallel. Other conditions, notably ocular tuberculosis, may radically alter this normal parallelism. A study of this relationship may affect our belief as to the time tuberculin therapy should be pushed or omitted. It may be shown that it should not be pushed during the periods of ocular activity, when the patient is secreting tuberculin in his own eye. The relationship of ocular sensitivity to cutaneous sensitivity in the various stages of ocular tuberculosis must be determined.

I should like to make one comment about purified protein derivative. This substance is valuable only for diagnostic purposes, and in the Phipps Clinic, in Philadelphia, the fact has been established that it is nonantigenic and that one cannot obtain desensitization with it. To obtain desensitization, some type of tuberculin itself must be used and not purified protein derivative. The essential point in the choice of tuberculin is that one use a standardized tuberculin of known activity.

So far as Dr. Verhoeff's criticism goes, we have no control series of patients with ocular tuberculosis and probably never shall have. Certain patients have not been treated, owing to active pulmonary complications or because of other contraindications. Since we are convinced of the value of tuberculin in ocular tuberculosis, we do not feel justified in withholding it from a series of patients whom we feel it would benefit. Hartig, in Germany, had a control series, and of his 14 patients from whom he withheld tuberculin he observed spontaneous improvement in only 1.

In regard to Dr. Knapp's question of the choice and dosage of tuberculin, as has previously been stated, one must have a tuberculin of known and standardized strength. There is no such thing as an absolute dose of tuberculin; the dosage must be regulated according to the reaction of the patient. We have abandoned, so far as possible, the perifocal plan of treatment and now usually treat all our patients on the basis of the desensitization theory. Here the essential point is to keep the dose just below the patient's point of reactivity. This requires constant observation and may be an exceedingly delicate and difficult thing to do.

Dr. Brown's question as to the relation of the general tuberculous status of the patient to the ocular activity is a pertinent one. Werdenberg insists that all patients with ocular tuberculosis exhibit definite roentgenographic evidence of pulmonary changes. In a great many of our cases we had roentgenograms made. That phase of the subject was not

discussed in this paper. I agree with Werdenberg that ocular tuberculosis is usually secondary to tuberculosis of the hilus glands, but I cannot agree that one can always demonstrate these changes. Certainly the American radiologists must read as negative pictures regarded by Werdenberg as showing slight fibrotic changes. We took the question up with Dr. Pierson, the head of the roentgenologic department at Johns Hopkins Hospital and University. We examined many old plates that were interpreted as negative, and undoubtedly they frequently showed low grade hilus shadows. Dr. Pierson takes the view that such changes are normally seen in adult patients and that the roentgenographic picture should therefore be considered negative. In our present series of cases we are attempting to correlate the exact changes in the hilus gland with the ocular tuberculosis.

FORMATION OF PRERETINAL CONNECTIVE TISSUE IN ACUTE CHOROIDITIS: REPORT OF THREE CASES. DR. ARNOLD KNAPP, New York.

This paper was published in full in the October 1937 issue of the ARCHIVES, page 558.

PATHOGENESIS OF DISCIFORM DEGENERATION OF THE MACULA. DR. F. H. VERHOEFF, Boston, and DR. HERMAN P. GROSSMAN (by invitation), Providence, R. I.

This paper was published in full in the October 1937 issue of the ARCHIVES, page 561.

DISCUSSION

DR. ALBERT N. LEMOINE, Kansas City, Mo.: The observations of Dr. Verhoeff and Dr. Grossman on the pathogenesis of disciform degeneration of the macula are exceedingly important to the ophthalmologist. These findings are not necessarily limited to lesions in the macula, but point to the possible pathogenesis of similar lesions elsewhere in the retina.

Now that the pathogenesis of these lesions has been demonstrated, with my observations as to the etiology of some of the intra-ocular capillary hemorrhages, it is highly possible that a number of these are due to vitamin C deficiency or mild scurvy. When there is increased capillary permeability sufficient to cause hemorrhages in the retinal vessels or choriocapillaris, one must think of arteriosclerosis or cardiovascular renal disease. However, one must not lose sight of the fact that some internists attribute some of those conditions to vitamin C deficiency. This deficiency might be due either to lack of assimilation or to intake of the vitamin C.

There is enough evidence to point to the possibility of some capillary intra-ocular hemorrhages being due to vitamin C deficiency to justify making the tourniquet test in all cases of idiopathic hemorrhages, and if such tests are made and the reactions are found to be positive, to administer cevitic acid.

DR. ARNOLD KNAPP, New York: I am glad that Dr. Verhoeff and Dr. Grossman have had the opportunity of examining some patients with disciform degeneration of the macula and of elucidating the pathologic picture. I have been interested in this condition since 1919, when

I presented before this society a case in which I made a diagnosis of sarcoma. I should like particularly to speak of the clinical differentiation between a tumor and an extravasation of blood in the macular region. Disciform degeneration occurs, in my experience, in older persons; the elevation is never more than 3 or 4 diopters; the outline is fairly round or oval, and the mass is amorphous either in the affected eye or in the other eye and usually gray or grayish white. There is definite evidence of arteriosclerosis. The occurrence of discoid macular degeneration in association with circinate retinitis was mentioned. While macular changes are frequent in cases of circinate retinitis, they are not like those described in this paper.

DR. THEODORE L. TERRY, Boston: I should like to report a case in which a small macular lesion of the right eye in a woman 29 years of age had the appearance of a malignant melanoma and produced a central scotoma. Dr. Beetham had the patient examined by several ophthalmologists before he removed the eye. The lesion proved to be typical disciform degeneration with associated hemorrhage and serum. In the choroid itself, subjacent to the disciform lesion, there was a nodule of chronic inflammatory cells. Another somewhat similar inflammatory lesion was situated near the nerve head.

Unfortunately, this case was brought to the attention of Dr. Verhoeff and Dr. Grossman too late for them to be able to include it in their paper. Dr. Verhoeff has studied these slides, and I should like to hear his interpretation of the findings.

DR. HERMAN P. GROSSMAN, Providence, R. I.: Dr. Knapp has presented a few points in the diagnosis of senile disciform degeneration of the macula, particularly as to the differentiation of this condition from sarcoma of the choroid. This differentiation is based on: (1) the shape and contour of the lesion, (2) the elevation of the mass and (3) the associated presence of retinal arteriosclerosis in disciform degeneration.

In many cases reported in the literature the contour of the lesion was not at all disciform. We are convinced that the configuration of the lesion is not helpful in the diagnosis. The height of the tumor is of little significance. The variation of elevation in the reported cases ranged from 0.5 to 6 diopters. Sarcoma in its later stages no doubt reaches a much greater height, but at that late stage this sign is no longer needed for confirmation of the diagnosis. In a summary of the literature retinal arteriosclerosis was mentioned in only 25 of the 129 cases. Retinal angiosclerotic vascular changes were found histologically in only a few of the eyes which were examined microscopically. These figures are, of course, of no significance whatever in a group of patients whose average age is 68. One can therefore place little reliance on this sign as an aid in differentiating disciform degeneration from sarcoma.

We believe that the important points in the differentiation of the conditions are these: Typical subretinal hemorrhages adjacent to the lesion are seldom if ever seen in cases of sarcoma. The location of the tumor is important, since sarcoma has no particular predilection for the macular region and seldom occurs at that point, whereas disciform degeneration always includes the macula.

Finally, in cases of sarcoma separation of the retina is very common and often appears to be entirely out of proportion to the size of the

tumor. On the other hand, in cases of disciform degeneration separation of the retina, when present, is slight and is often not sufficient to be recognizable by ordinary ophthalmoscopic investigation.

DR. F. H. VERHOEFF, Boston: Dr. Lemoine's observations are interesting. There must, of course, be a great variety of causes of petechial hemorrhages, and vitamin deficiency may be one of them, but we have no evidence of that in our cases. We know that subconjunctival hemorrhages occur at times without the cause ever being detected. No doubt, in the majority of the cases of senile disciform degeneration the hemorrhage results from an arteriosclerotic process. In some of these cases there are hemorrhages away from the lesion, but I think most of these hemorrhages are really blood that has extended under the retina from the main mass. In patients with arteriosclerosis there may be retinal hemorrhages independent and separate from the main mass.

Dr. Knapp stated that he believed that there was no connection between disciform degeneration of the macular region and circinate retinitis. A number of cases of circinate retinitis associated with this condition have been reported in the literature. I recently saw 2 cases in the clinic. In 1 there were circinate lesions in the retina over the mound. The relation of the two conditions is described in our paper.

In Dr. Beetham's case, referred to by Dr. Terry, it was evident the small lesion in the macula was of the same nature as those in the senile type of disciform degeneration. I found blood still present in the mound and also blood around it. The striking thing in this case was the marked lymphocytic infiltration of the choroid behind the mound. I saw Dr. Knapp's specimen (he sent a section to me at the time), and I have seen sections of the lesions in 5 other cases, and in none of them was there such marked lymphocytic infiltration.

In Dr. Beetham's case there was also lymphocytic infiltration at the margin of the disk entirely independent of the other, so it would seem that there must have been a low grade metastatic infection. Here is an instance of a disciform lesion in a young person similar to those occurring in elderly persons. The patient was only 29, and the lesion never could have subsided without marked impairment of vision resulting. In this way it was also like the senile type of lesion. In this case, however, the cause of the hemorrhage was different, no doubt. The patient did not have arteriosclerosis. There are probably a great many conditions which lead to hemorrhage from the choriocapillaris. All I wish to point out is that a typical lesion is due to organization of a hemorrhagic extravasation which is primarily beneath the pigment epithelium. In some cases the hemorrhage may be due to urticaria. I can even bring my favorite factor, allergy, into the question. It is useless, however, to discuss all these points unless one has definite evidence of them.

THE GENESIS OF THE CYCLITIC MEMBRANE. DR. HARVEY D. LAMB, St. Louis.

The cyclitic membrane formed at the inner free surface of the ciliary body is an example of productive fibrosis. It originates in association with chronic cyclitis, in which the most constant symptom is an exudation of macrophages into the adjacent vitreous. At the latter site, the macro-

phages become fibroblasts and form the cyclitic membrane. Some examples of this incipient formation are described and illustrated with photomicrographs.

NEUROGENIC ORIGIN OF CHOROIDAL SARCOMA. DR. GEORGIANA DVORAK-THEOBALD, Oak Park, Ill.

This paper was published in full in the December 1937 issue of the ARCHIVES, page 971.

INFLAMMATORY PSEUDOTUMOR OF THE ORBIT: REPORT OF A CASE. DR. PHILIP M. LEWIS, Memphis.

A case of pseudotumor of the orbit with satisfactory surgical removal is reported.

DISCUSSION

DR. C. A. CLAPP, Baltimore: In discussing this paper I wish to report a case that is almost identical in history and appearance. It occurred in a man of about 40, who first noticed beginning proptosis in July 1936. I first saw him in September 1936, at which time he had 4 mm. of proptosis with limited motion but normal visual fields. The proptosis increased, however, and even in the presence of a negative Wassermann reaction he was treated with both mercuric and potassium iodide, without result. He was also given irradiation therapy, which was likewise without result. The proptosis increased until it measured 8 mm. and hemorrhages began to appear in the fundus. As consultants agreed with my opinion that an orbital growth was present, and in view of the severe pain, dissection was made above, and the tumor, or pseudotumor, was found to extend clear to the optic foramen. A frozen section was made, and "suspected malignancy" was reported. The tumor, or growth, including the apex of the muscle cone, was removed. The photomicrograph of the tissue is similar to that in Dr. Lewis' case. There has been considerable discussion as to the diagnosis. Dr. Rich, of the pathologic department, is of the opinion that it is an inflammatory growth, and Dr. Friedenwald believes that it is syphilitic. In view, however, of the repeated negative Wassermann reactions, and since the patient showed no improvement on antisyphilitic treatment, I doubt very much, at least from the clinical aspect, whether this growth was of syphilitic origin.

DR. ALGERNON B. REESE, New York: I should like to cite a case of pseudotumor of the orbit with some unusual features. The woman had a proptosis of the right eye, and through the upper and lower lids, at the inner canthus, a mass was palpable. A biopsy specimen, secured by aspiration, showed the usual chronic inflammatory granuloma. In the course of six months the eye receded, and slight enophthalmos ensued. After six months the left eye protruded, and through the lower lid, at the external canthus, a mass was palpable. The exophthalmometer readings showed that the left eye was 6 mm. more prominent than the right. This difference between the two eyes was not due entirely to the exophthalmos on the left side but also to the enophthalmos on the right side. After one month the difference in the two eyes was only 2 mm.; in another month it was only 1 mm., and three months later there was

an enophthalmos of the left eye. The eyes remained the same for two years more, and then the left eye again protruded 5 mm. At the same time there appeared a large, smooth, somewhat firm mass over the forehead, and a biopsy specimen secured by aspiration showed that it was a chronic inflammatory granuloma. After two months the exophthalmos began to recede, until it was only 4 mm. In two months more it was only 1 mm. Six months later there was an enophthalmos of 2 mm.; that is, the exophthalmometer reading on the left eye was 15 and on the right eye, 13. The only possible indication of the etiology was that the roentgenographic examinations showed an elevation of the outer table of the frontal bone, and there was a denseness in both antrums, thus suggesting the possibility that an inflammatory granuloma had extended from the sinuses into the orbit and over the frontal bone.

CYST OF THE POSTERIOR CHAMBER. DR. ERNEST F. KRUG, New York.

A case is reported in which a cyst of the posterior chamber developed nine years after injury to the globe and was treated by electrocoagulation. It reappeared after eighteen months, and the electrocoagulation was repeated. Two months later the cyst again reappeared with secondary glaucoma, necessitating removal of the eyeball.

DISCUSSION

DR. F. H. VERHOEFF, Boston: Apparently it is technically correct to speak of this growth as a cyst of the posterior chamber, although the cyst did not originally occupy the posterior chamber. It is unfortunate that this title had to be used, because it gives a wrong impression, namely, that the case differs from that of a cyst in the anterior chamber following a perforating wound. I can recall 3 cases in which I have operated for epithelial cyst of the anterior chamber. The results were successful in all 3.

The point I wish to make is this: In such cases it is well worth while to attempt to remove the cysts, even if one does not succeed in excising all the epithelium. I believe that the eye can harbor a certain amount of it: possibly as a result of the operation the epithelium is incarcerated in scar tissue so that it does not proliferate.

DR. THEODORE L. TERRY, Boston: That Dr. Krug has used the term "epithelial cyst of the posterior chamber" is of some importance, because it shows that an implantation epithelial cyst can extend into the posterior chamber.

In examining the sections in the laboratory of the Massachusetts Eye and Ear Infirmary, 2 instances of epithelium in the posterior chamber were found, a coloboma of the iris being present in each. No case of epithelial cyst in the posterior chamber was discovered, however.

In Dr. Krug's case it is interesting to note that the epithelium lining the cyst varies greatly in the number of its layers. Although this is not necessarily important, the fact that the epithelium is reduced to one or two layers in that region of the cyst exposed to the aqueous and that the central area of this free portion shows necrosis of the epithelium may indicate that the aqueous does not bring it sufficient nutrition or that there is some growth-retarding factor in the aqueous. This behavior

of the aqueous, I believe, has been suggested by those who are particularly experienced in corneal grafting. This is further borne out by the fact that in other localities it is possible to find blood vessels in contact with the cyst.

In view of Dr. Verhoeff's observations, attempted removal would apparently be a worthwhile procedure; however, the size and nature of this cyst would have made complete removal difficult or, more probably, impossible.

DR. ARNOLD KNAPP, New York: May I speak on the question of treating a cyst of the iris by electrocoagulation? The patient I wish briefly to refer to was a woman operated on for a cataract a year before I saw her, and when she came to me she had a broad adhesion of the iris and of the capsule to the section, a well developed cyst in the iris and increased tension. The cyst was treated by electrocoagulation in the usual manner, and the result was very favorable for eight months. After that time the tension returned; it was difficult to tell whether the return of the tension was due to the adhesion of the iris and capsule or to a return of the cyst. In any case, cyclodialysis was done. This made matters worse, and the eye gradually became phthisic. I do not feel that electrocoagulation is of great help in these cases, nor do I believe that a cyst like this could be removed by an operative procedure.

DR. P. CHALMERS JAMESON, Brooklyn: Dr. Krug's interesting case recalls one that I saw a year ago. About twenty years previously a young boy had both eyes injured by an explosion. I had to enucleate one eye, which was severely wounded, and extract the lens of the other, which had a perforating wound of the iris. About twenty years later, i. e., last year, a large cyst developed, extending from the lower limbus well into the small pupil which I had retained for him. All through these years he had maintained vision of 20/30. I was undecided as to what treatment to pursue.

At a meeting of the New York Ophthalmological Society a case was reported in which a solution of iodine had been injected. The technic was interesting. A few drops of tincture of iodine was removed in a pipet; the fluid from the cyst was withdrawn and allowed to mix with the tincture of iodine; the mixture thus obtained was injected into the cyst before the needle was withdrawn. In this case there was no reaction, and a perfect result was obtained.

My own surgical experience in removing these cysts has not been successful. I have not done many of these extirpations, but the cysts have nearly always recurred. The result so far as the destruction of the cyst was concerned was satisfactory, but later a condition developed which resembled multiple tubercle nodules. I did everything I could, and yet the pupil is occluded, and an active inflammatory condition has continued over the past year.

With regard to the suggestion relative to electrocoagulation, one notes that in the 2 cases just reported glaucoma developed later. While electrocoagulation destroys the cyst itself, is it not possible that the amount of heat required and generated to destroy the cyst may impair the tissues at the filtration angle so that a glaucoma would later develop? That is the consideration which would possibly prevent me from using

electrocoagulation in this region, and as surgical treatment is not always successful, one may have to rely on the injection of chemical solutions to destroy the walls of the cyst.

POSTERIOR SCLEROTOMY AS A FORM OF TREATMENT IN SUBCHOROIDAL EXPULSIVE HEMORRHAGE. DR. DERRICK VAIL, Cincinnati.

Two cases are reported in which it was felt certain that posterior sclerotomy saved the eye and prevented complete deterioration of vision.

The first case was that of a woman aged 41 who had undergone an operation for the removal of cataract from the right eye. The next day, while the wound was being dressed, typical symptoms of subchoroidal hemorrhage occurred, with a gaping wound. A Graefe knife was plunged into the temporal side of the eyeball, about 14 mm. from the limbus, leading to the appearance of bright red blood and the subsidence of pain within a relatively short time. Later the coagulated blood, tangled iris and coagulated vitreous between the lips of the gaping wound were excised, and the cornea was sutured to the sclera. About six weeks later iridectomy was performed, and the vision eventually was 20/25, with correction.

The second case was that of a woman of 65 who had noninflammatory glaucoma of the right eye following iridectomy with a Graefe knife; choroidal symptoms of expulsive subchoroidal hemorrhage appeared. An incision in the temporal side of the eyeball resulted in the appearance of bright red blood, which flowed for about two minutes, at the end of which time the pain was less, but still severe. Convalescence from then on was uneventful. The tension at the time of the patient's discharge was entirely normal, and the vision, which had been 20/25, was 20/200. In both cases there was a white streak in the choroid on the temporal side radiating up as far as could be traced anteriorly.

DISCUSSION

DR. BERNARD SAMUELS, New York: Dr. Vail has requested me to base my discussion on an examination of three of his lantern slides.

The first slide represents a typical nonexpulsive subchoroidal hemorrhage. The difference between this type and the ordinary expulsive hemorrhage consists in the fact that in the nonexpulsive hemorrhage there is no rupture in the choroid, but in the expulsive hemorrhage, in which the eye is always lost, the choroid ruptures and almost the entire contents are extruded. The nonexpulsive hemorrhages are nearly always more marked on the temporal side. The retina is never detached, because the retina and choroid are pressed together against the vitreous. These subchoroidal hemorrhages take place far forward, and posteriorly they seldom reach to the margin of the optic nerve, leaving a considerable zone surrounding the optic nerve.

The second slide is that of a glaucomatous eye in the horizontal meridian. The eye was not removed until ten days after iridectomy. Nonexpulsive hemorrhages do not always occur just at the time of the operation but may take place a number of hours afterward. In this respect they differ from the ordinary serous choroidal detachments described by Dr. O'Brien before this society. A serous detachment occurs slowly, because it takes a much longer time for transudate to

accumulate than for a hemorrhage. In serous detachment the globe is soft, whereas in nonexpulsive subchoroidal hemorrhage the blood accumulates rapidly. In the latter cases the eyeball is hard.

The third globe is cut in the vertical meridian, taking in the site of a trephine operation. At the end of the operation the vitreous presented itself in the wound. The eye was not enucleated until some days later. The blood in the subchoroidal space is remarkable because it is so well preserved. It shows how difficult it is for the choroid to become detached in the neighborhood of the veins of the vortex. The hemorrhage is the result of a rupture in one or both of the long posterior ciliary arteries. Most of the ruptures of the blood vessels seem to occur on the temporal side, and it is on this side that there is the greatest accumulation of blood.

According to laboratory experience, nonexpulsive subchoroidal hemorrhage occurs more frequently after the trephine and the Lagrange operation than after simple iridectomy. The explanation is that after these operations the globes remain soft for a long time. Whereas the diseased blood vessels might withstand a reduction in tension for a short period, they would be more likely to rupture if the reduced tension continued over a prolonged period.

CORRECTIONS

In the article "Technic of Goniotomy" by Dr. Otto Barkan in the February issue (*ARCH. OPHTH.* 19: 217, 1938), the sentence beginning with the word "Reoperation" in the tenth line of the first paragraph on page 223 should read: "Reoperation in these cases will presumably normalize tension without the use of miotics. In a few cases in which the trabeculum was missed or the canal was not opened there has not been any effect on the intra-ocular pressure and reoperation will be required."

In the article by Drs. Abraham Myerson and William Thau entitled "Human Autonomic Pharmacology: IX. Effect of Cholinergic and Adrenergic Drugs on the Eye" (*ARCH. OPHTH.* 18: 78 [July] 1937), "mydriasis" should be substituted for "miosis and cycloplegia" in the last line.

Book Reviews

Die Funktionsprüfung des Auges unter besonderer Berücksichtigung der Störungen des Farbensinnes. By Prof. Dr. Hans Oloff and Dr. Hans Podestà. Price, 7.50 marks. Pp. 198. Berlin: Julius Springer, 1937.

This book includes a second, enlarged and completed edition of the "Diagnostik der Farbensinnstörungen" of Stargardt and Oloff, which appeared in 1912.

The examination for color vision is a problem not well understood by many oculists. Hence, an exhaustive description of this examination is given, occupying more than half the text, and other tests for vision are added. These consist of the examination of vision, of light sense and of ocular motility. The main reason for these tests is that they concern safety in traffic, and only those tests are described which have proved to be essential, easily applied and reliable.

The part of the text dealing with the examination of color vision follows a chapter on the examination of visual acuity and on the chief refractive anomalies. The importance of color vision in one's daily life and activity is dwelt on. The exact determination of the type of defect in color vision is of secondary importance, except for scientific study and in the selection of certain professions. The tests for color vision can be made only by properly trained physicians. The defect cannot be relieved by any treatment and remains a congenital and transmissible condition. The material on the history, the development of color sense, the frequency of defects and its inheritance is followed by an analysis of normal color vision, the grades of color perception, the laws of spectral color mixtures, the theories of color perception and sections dealing with the color vision of the dichromats, the abnormal trichromats, color asthenopia, total color blindness and the acquired disturbances of color vision.

Diagnosis of disturbances of color vision is made with spectral light; samples of pigment, which include Holmgren's wool; colored crayons; pseudo-isochromatic charts; colored signal lights, and lanterns. The field of vision, light sense, motor anomalies, stereoscopic vision and simulation are also described. The German requirements for the army and the navy, for aviation and for railroads and motor vehicles are given in a concluding chapter.

This is an excellent manual, and the chapters on color vision and its disturbances are particularly worthy of praise. The text is clearly written and the printing is good, but it seems a pity that all illustrations have been omitted.

ARNOLD KNAPP.

Zur Therapie der Embolie der Zentralarteria der Retina. By Dr. Ernst Johansson, Zeitschrift für Augenheilkunde, supp. 24. Price, 6.40 marks. Pp. 86. Berlin: S. Karger, 1937.

After a brief description of the clinical picture known as embolism of the central retinal artery, it is stated that the cause is generally to be found in lesions or disorders (1) of the heart and vessels

(2) of the endothelium and (3) of the blood. It has been found that the sinking reaction of the erythrocytes is increased. A prophylactic agent containing an injectable extract prepared from fresh liver (camponol) has been found of value in some cases. Intravenous injections of eupaverin have been used successfully to relieve the spasm; the action of the drug was found to be of three hours' duration, and it must be given during the first ten hours. A good therapeutic agent consists of eupaverin 0.03 Gm., atropine methylbromate 0.0003 Gm. and aminopyrine 0.15 Gm., which is given in tablets and suppositories. Many forms of treatment are described, with references to the literature, and brief histories are added. Of 103 cases in which healing or improvement occurred, massage was successful in 30; operation in 27 (paracentesis in 16); blood letting, the administration of digitalis, the injection of a pancreatic preparation (angioxyl) and of atropine in 4 each, and the administration of acetylcholine in 7, of amyl nitrite in 2 and of strychnine and nitrites in 1, while spontaneous recovery took place in 16. In the last three years the author has observed and treated 9 patients with arterial closure, and the details concerning them are given. In conclusion, the following treatment is recommended: the injection of eupaverin, vibratory massage, the administration of padutin, the injection of atropine the administration of acetylcholine or operation (paracentesis). Prophylactically, the injection of the extract prepared from fresh liver is suggested.

ARNOLD KNAPP.

Manual of the Diseases of the Eye. By Charles H. May, M.D. Fifteenth edition. Price, \$4. Pp. 498, with 376 original illustrations, including 25 plates, with 78 colored figures. Baltimore: William Wood and Company, 1937.

The new edition of this well known manual has been thoroughly revised, with the assistance of Dr. Charles A. Perera.

The chapters on the ophthalmoscope and on the ocular manifestations of general diseases have been rewritten; changes and additions have been made in the description of operations on the lids and for detachment of the retina. Additions have been incorporated, such as those dealing with dinitrophenol cataract, inclusion bodies, inclusion blenorrhea, acetylcholine therapy, "floaters," gonioscopy, the use of (paranormobutylaminobenzoyldimethylaminoethanol) pontocaine hydrochloride, recumbent spectacles and polaroid glass. Some new illustrations have been added, and others have been replaced.

Though the volume has been thoroughly brought up to date and many improvements have been added, it has not been increased in size. It continues to be one of the best textbooks for the undergraduate student and for the general practitioner.

ARNOLD KNAPP.

Directory of Ophthalmologic Societies *

INTERNATIONAL

INTERNATIONAL ASSOCIATION FOR PREVENTION OF BLINDNESS

Honorary President: Prof. F. de Lapersonne, 217 Fauborg St. Honoré, Paris.
President: Dr. P. Bailliart, 66 Boulevard Saint-Michel, Paris, 6^e.
Secretary-General: Prof. M. Van Duyse, Université de Gand, Gand, Prov. Ostflandern, Belgium.
All correspondence should be addressed to the President, Dr. P. Bailliart.

INTERNATIONAL OPHTHALMOLOGIC CONGRESS

Secretary: Dr. E. Marx, Costzeedijk 316, Rotterdam, Netherlands.

INTERNATIONAL ORGANIZATION AGAINST TRACHOMA

President: Dr. A. F. MacCallan, 33 Welbeck St., London, W., England.

FOREIGN

BRITISH MEDICAL ASSOCIATION, SECTION ON OPHTHALMOLOGY

President: Dr. Stewart Duke-Elder, 59 Harley St., London, W. I.
Secretary: Dr. Thomasina Belt, 13 Mitchell Ave., Jesmond, Newcastle-on-Tyne.
Place: Plymouth. Time: July 20-22, 1938.

CHINESE OPHTHALMOLOGICAL SOCIETY OF PEIPING

President: Dr. H. T. Pi, Peiping Union Medical College, Peiping.
Secretary: Dr. C. K. Lin, 180 Hsi-Lo-yen, Chienmeng, Peiping.
Place: Peiping Union Medical College, Peiping. Time: Last Friday of each month.

GERMAN OPHTHALMOLOGICAL SOCIETY

President: Prof. Lohlein, Jena.
Secretary: Prof. A. Wagenmann, Heidelberg.
Place: Heidelberg. Time: July 4-6, 1938.

MIDLAND OPHTHALMOLOGICAL SOCIETY

President: Dr. T. E. Ashdown Carr, 34 Charnwood St., Derby, England.
Secretary: T. Harrison Butler, 81 Edmund St., Birmingham, England.
Place: Birmingham and Midland Eye Hospital.

OPHTHALMOLOGICAL SOCIETY OF EGYPT

President: Prof. Dr. Sayed Abdel Hamid Soliman Pasha, Faculty of Medicine, Cairo.
Secretary: Dr. Abdel Fattah El Tobgy, 3 Midan Soliman Pasha, Cairo.
Place: Memorial Ophthalmic Laboratory, Giza. Time: March 25, 1938.

OPHTHALMOLOGICAL SOCIETY OF THE UNITED KINGDOM

President: Mr. Gordon M. Holmes, 9 Wimpole St., London, W. 1.
Secretary: Mr. J. D. M. Cardell, 27 Weymouth St., London, W. 1.

OPHTHALMOLOGY SOCIETY OF BOMBAY

President: Dr. D. D. Sathaye, 127 Girgaum Road, Bombay 4.
Secretary: Dr. H. D. Dastur, Dadar, Bombay 14.
Place: H. B. A. Free Ophthalmic Hospital, Parel, Bombay 12. Time: First Friday of every month.

* Secretaries of societies are requested to furnish the information necessary to make this list complete and to keep it up to date.

OXFORD OPHTHALMOLOGICAL CONGRESS

Master: Dr. C. G. Russ Wood, Hill House, Abberbury Rd., Iffley, Oxford, England.

Hon. Secretary-Treasurer: Dr. F. A. Anderson, 12 St. John's Hill, Shrewsbury, England.

Time: July 7-9, 1938.

PALESTINE OPHTHALMOLOGICAL SOCIETY

President: Dr. Arie Feigenbaum, Abyssinian Str. 15, Jerusalem.

Secretary: Dr. E. Sinai, Tel-Aviv.

POLISH OPHTHALMOLOGICAL SOCIETY

President: Dr. W. Kapuściński, 2 Waly Batorego, Poznań.

Secretary: Dr. J. Sobański, Lindley'a 4, Warsaw.

Place: Lindley'a 4, Warsaw.

ROYAL SOCIETY OF MEDICINE, SECTION OF OPHTHALMOLOGY

President: Dr. Ransom Pickard, 31 E. Southernhay, Exeter, England.

Secretary: Dr. A. Rugg-Gunn, 35 Harley St., London, W. 1.

SOCIÉTÉ FRANÇAISE D'OPHTHALMOLOGIE

Secretary: Dr. René Onfray, 6 avenue de la Motte Picquet, Paris, 7è.

SOCIETY OF SWEDISH OPHTHALMOLOGISTS

President: Prof. K. G. Ploman, Stockholm, Sweden.

Secretary: Dr. K. O. Granström, Södermalmstorg 4 III tr., Stockholm, Sö., Sweden.

TEL-AVIV OPHTHALMOLOGICAL SOCIETY

President: Dr. D. Arie Friedman, 96 Allenby Str., Tel-Aviv.

Secretary: Dr. Sadger Max, 9 Bialik Str., Tel-Aviv.

TSINAN OPHTHALMOLOGICAL SOCIETY

Chairman: Dr. Eugene Chan, Cheeloo University School of Medicine, Tsinan, Shantung.

Place: Cheeloo University School of Medicine. Time: Last Thursday of alternate months.

NATIONAL

AMERICAN MEDICAL ASSOCIATION, SCIENTIFIC ASSEMBLY, SECTION ON OPHTHALMOLOGY

Chairman: Dr. Parker Heath, 1553 Woodward Ave., Detroit.

Secretary: Dr. Derrick T. Vail Jr., 441 Vine St., Cincinnati.

Place: San Francisco. Time: June 13-17, 1938.

AMERICAN ACADEMY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY, SECTION ON OPHTHALMOLOGY

President: Dr. Harry S. Gradle, 58 E. Washington St., Chicago.

Executive Secretary-Treasurer: Dr. William P. Wherry, 1500 Medical Arts Bldg., Omaha.

Place: Washington, D. C. Time: Oct. 9-14, 1938.

AMERICAN OPHTHALMOLOGICAL SOCIETY

President: Dr. Frederick H. Verhoeff, 243 Charles St., Boston.

Secretary-Treasurer: Dr. Eugene M. Blake, 303 Whitney Ave., New Haven, Conn.

Place: San Francisco. Time: June 9-11, 1938.

CANADIAN OPHTHALMOLOGICAL SOCIETY

President: Dr. W. Gordon M. Byers, 1458 Mountain St., Montreal.

Secretary-Treasurer: Dr. Alexander E. MacDonald, 421 Medical Arts Bldg., Toronto.

NATIONAL SOCIETY FOR THE PREVENTION OF BLINDNESS

President: Mr. William Fellowes Morgan, 50 W. 50th St., New York.
Secretary: Miss Regina E. Schneider, 50 W. 50th St., New York.

SECTIONAL

CENTRAL WISCONSIN SOCIETY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

President: Dr. L. C. Gardner, 11 N. Main St., Fond du Lac.
Secretary: Dr. G. L. McCormick, 626 S. Central Ave., Marshfield.
Place: Marshfield. Time: May 1938.

NEW ENGLAND OPHTHALMOLOGICAL SOCIETY

President: Dr. Edwin B. Goodall, 101 Bay State Rd., Boston.
Secretary-Treasurer: Dr. William P. Beetham, 5 Bay State Rd., Boston.
Place: Massachusetts Eye and Ear Infirmary, 243 Charles St., Boston. Time:
8 p. m., third Tuesday of each month from November to April, inclusive.

PACIFIC COAST OTO-OPHTHALMOLOGICAL SOCIETY

President: Dr. William D. Donohue, 1930 Wilshire Blvd., Los Angeles.
Secretary-Treasurer: Dr. C. Allen Dickey, 450 Sutter St., San Francisco.
Place: Victoria, B. C. Time: June 21-24, 1938.

PUGET SOUND ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. A. W. Howe, 740 St. Helens Ave., Tacoma, Wash.
Secretary-Treasurer: Dr. Purman Dorman, 1115 Terry Ave., Seattle.
Place: Seattle or Tacoma, Wash. Time: Third Tuesday of each month, except
June, July and August.

ROCK RIVER VALLEY EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. Frank W. Broderick, 501 Central Trust Bldg., Sterling, Ill.
Secretary-Treasurer: Dr. Thorsten E. Blomberg, 501-7th St., Rockford, Ill.
Place: Rockford, Ill., or Janesville or Beloit, Wis. Time: Third Tuesday of
each month.

SAGINAW VALLEY ACADEMY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

President: Dr. W. K. Slack, 308 Eddy Bldg., Saginaw, Mich.
Secretary-Treasurer: Dr. Andre Cortopassi, 703 Second National Bank Bldg.,
Saginaw, Mich.
Place: Saginaw or Bay City, Mich. Time: Second Tuesday of each month,
except July and August.

SIOUX VALLEY EYE AND EAR ACADEMY

President: Dr. J. H. Judd, 107 S. 17th St., Omaha, Neb.
Secretary-Treasurer: Dr. J. C. Decker, 515 Frances Bldg., Sioux City, Iowa.

SOUTHERN MEDICAL ASSOCIATION, SECTION ON EYE, EAR, NOSE AND THROAT

Chairman: Dr. Grady E. Clay, Medical Arts Bldg., Atlanta, Ga.
Secretary: Dr. John R. Hume, 921 Canal St., New Orleans.

SOUTHWESTERN MICHIGAN TRIOLOGICAL SOCIETY

President: Dr. John Hunter McRae, 26 Sheldon Ave., S. E., Grand Rapids, Mich.
Secretary-Treasurer: Dr. Dewey R. Heetderks, 405 Medical Arts Bldg., Grand
Rapids, Mich.
Time: Third Thursday of alternate months.

WESTERN PENNSYLVANIA EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. C. M. Harris, Johnstown, Pa.
Secretary-Treasurer: Dr. C. Wearne Beals, Weber Bldg., DuBois.
Place: Johnstown, Pa. Time: May 19, 1938.

STATE

COLORADO OPHTHALMOLOGICAL SOCIETY

President: A presiding officer is selected for each meeting alternately until all members have served.

Secretary: Dr. John C. Long, 324 Metropolitan Bldg., Denver.

Place: Capitol Life Bldg., Denver. Time: 7:30 p. m., third Saturday of the month, October to April, inclusive.

CONNECTICUT STATE MEDICAL SOCIETY, SECTION ON EYE, EAR,
NOSE AND THROAT

President: Dr. Charles T. Flynn, 41 Trumbull St., New Haven.

Secretary-Treasurer: Dr. Shirley H. Baron, 309 State St., New London.

Place: New London. Time: February 1938.

EYE, EAR, NOSE AND THROAT CLUB OF GEORGIA

President: Dr. John King, Thomasville.

Secretary-Treasurer: Dr. Mason Baird, 384 Peachtree St., Atlanta.

Place: Augusta. Time: May 1938.

INDIANA ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. E. E. Holland, 51 S. 8th St., Richmond.

Secretary: Dr. Marlow W. Manion, 23 E. Ohio St., Indianapolis.

Place: Indianapolis. Time: April 6, 1938.

IOWA ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. H. H. Lamb, American Bank Bldg., Davenport.

Secretary-Treasurer: Dr. B. M. Merkel, 604 Locust St., Des Moines.

Place: Davenport.

LOUISIANA-MISSISSIPPI OPHTHALMOLOGICAL AND OTOLARYNGOLOGICAL SOCIETY

President: Dr. C. A. McWilliams, G. and S. I. R. R. Bldg., Gulfport, Miss.

Secretary-Treasurer: Dr. Edley H. Jones, 1301 Washington St., Vicksburg, Miss.

Place: New Orleans. Time: Spring, 1938.

MICHIGAN STATE MEDICAL SOCIETY, SECTION OF OPHTHALMOLOGY
AND OTOLARYNGOLOGY

Chairman: Dr. F. N. Smith, Grand Rapids Clinic, Grand Rapids.

Secretary: Dr. Dewey R. Heetderks, 26 Sheldon Ave., S. E., Grand Rapids.

MINNESOTA ACADEMY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

President: Dr. Walter E. Camp, 1918 Medical Arts Bldg., Minneapolis.

Secretary-Treasurer: Dr. George E. McGeary, 920 Medical Arts Bldg., Minneapolis.

Time: Second Friday of each month from October to May.

MONTANA ACADEMY OF OTO-OPHTHALMOLOGY

President: Dr. Edward S. Murphy, Northern Pacific Hospital, Missoula.

Secretary: Dr. A. W. Morse, 507 Phoenix Bldg., Butte.

NEW JERSEY STATE MEDICAL SOCIETY, SECTION ON OPHTHALMOLOGY,
OTOLOGY AND RHINOLARYNGOLOGY

Chairman: Dr. Oram Kline, 414 Cooper St., Camden.

Secretary: Dr. James S. Shipman, 542 Cooper St., Camden.

NEW YORK STATE MEDICAL SOCIETY, EYE, EAR, NOSE AND THROAT SECTION

Chairman: Dr. Marvin F. Jones, 121 E. 60th St., New York.

Secretary: Dr. Algernon B. Reese, 73 E. 71st St., New York.

Time: May 10, 1938.

NORTH CAROLINA EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. J. M. Lilly, 302 Old St., Fayetteville.
 Secretary-Treasurer: Dr. Frank C. Smith, 106 W. 7th St., Charlotte.
 Place: Charlotte. Time: October.

NORTH DAKOTA ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. H. Rosenberger, 221-5th St., Bismarck.
 Secretary-Treasurer: Dr. F. L. Wicks, 514-6th St., Valley City.
 Place: Bismarck. Time: May 1938.

OREGON ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. A. B. Dykman, Medical Dental Bldg., Portland.
 Secretary-Treasurer: Dr. Andrew J. Browning, 418 Mayer Bldg., Portland.
 Place: Good Samaritan Hospital. Time: Third Tuesday of each month.

RHODE ISLAND OPHTHALMOLOGICAL AND OTOLOGICAL SOCIETY

Acting President: Dr. N. Darrell Harvey, 112 Waterman St., Providence.
 Secretary-Treasurer: Dr. Linley C. Happ, 124 Waterman St., Providence.
 Place: Rhode Island Medical Library. Time: 8:30 p. m., second Thursday in October, December, February and April.

SOUTH CAROLINA SOCIETY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

President: Dr. George Truluck, Orangeburg.
 Secretary: Dr. J. W. Jervey Jr., 101 Church St., Greenville.

TENNESSEE ACADEMY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

President: Dr. Kate Savage Zerfoss, 165-8th Ave., N., Nashville.
 Secretary-Treasurer: Dr. W. D. Stinson, 805 Medical Arts Bldg., Memphis.
 Place: Nashville. Time: April 12-13, 1938.

TEXAS OPHTHALMOLOGICAL AND OTO-LARYNGOLOGICAL SOCIETY

President: Dr. T. E. Fuller, 100 W. Board St., Texarkana, Texas.
 Secretary: Dr. O. M. Marchman, 1719 Pacific Ave., Dallas.

UTAH OPHTHALMOLOGICAL SOCIETY

President: Dr. V. P. White, 143½ S. Main St., Salt Lake City.
 Secretary-Treasurer: Dr. E. B. Fairbanks, Boston Bldg., Salt Lake City.
 Time: Third Monday of each month.

VIRGINIA SOCIETY OF OTO-LARYNGOLOGY AND OPHTHALMOLOGY

President: Dr. M. H. Hood, 505 Washington St., Portsmouth.
 Secretary-Treasurer: Dr. Charles T. St. Clair, 418 Bland St., Bluefield, W. Va.

WEST VIRGINIA STATE MEDICAL ASSOCIATION, EYE, EAR, NOSE
AND THROAT SECTION

President: Dr. George Traugh, 309 Cleveland Ave., Fairmont.
 Secretary: Dr. Welch England, 621½ Market St., Parkersburg.

LOCAL

ACADEMY OF MEDICINE OF NORTHERN NEW JERSEY, SECTION ON
EYE, EAR, NOSE AND THROAT

President: Dr. James A. Fisher, 501 Grand Ave., Asbury Park.
 Secretary: Dr. William F. McKim, 488 Sanford Ave., Newark.
 Place: 91 Lincoln Park South, Newark. Time: 8:45 p. m., second Monday of each month, October to May.

AKRON ACADEMY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

President: Dr. L. E. Brown, Second National Bldg., Akron.
Secretary-Treasurer: Dr. C. R. Anderson, 106 S. Main St., Akron.
Time: First Monday in January, March, May and November.

ATLANTA EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. J. Mason Baird, Medical Arts Bldg., Atlanta, Ga.
Secretary: Dr. Alton V. Hallum, 478 Peachtree St., Atlanta, Ga.
Place: Academy of Medicine, 38 Prescott St. Time: Second Friday of each month from October to May.

BALTIMORE MEDICAL SOCIETY, SECTION ON OPHTHALMOLOGY

Chairman: Dr. Henry F. Graff, 513 N. Charles St., Baltimore.
Secretary: Dr. Frank B. Walsh, Wilmer Institute, Johns Hopkins Hospital, Baltimore.
Place: Medical and Chirurgical Faculty, 1211 Cathedral St. Time: 8:30 p. m., fourth Thursday of each month from October to May.

BROOKLYN OPHTHALMOLOGICAL SOCIETY

President: Dr. Walter V. Moore, 1 Nevins St., Brooklyn.
Secretary-Treasurer: Dr. Mortimer A. Lasky, 1 Nevins St., Brooklyn.
Place: Kings County Medical Society Bldg., 1313 Bedford Ave. Time: Third Thursday in February, April, May, October and December.

BUFFALO OPHTHALMOLOGIC CLUB

President: Dr. Ivan J. Koenig, 40 North St., Buffalo.
Secretary-Treasurer: Dr. Meyer H. Rivchun, 367 Linwood Ave., Buffalo.
Time: Second Thursday of each month.

CHATTANOOGA SOCIETY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

President: Each member, in alphabetical order.
Secretary: Dr. A. H. Benz, 706 Medical Arts Bldg., Chattanooga.
Place: Mountain City Club. Time: Second Thursday of each month from September to May.

CHICAGO OPHTHALMOLOGICAL SOCIETY

President: Dr. Thomas D. Allen, 122 S. Michigan Blvd., Chicago.
Secretary-Treasurer: Dr. Earle B. Fowler, 55 E. Washington St., Chicago.
Place: Medinah Michigan Avenue Club, 505 N. Michigan Ave. Time: Third Monday of each month from October to May.

CINCINNATI OPHTHALMIC CLUB

Chairman: Each member, in rotation.
Secretary-Treasurer: Dr. E. R. Thomas, 819 Carew Tower, Cincinnati.
Place: Holmes Memorial Library, Cincinnati General Hospital. Time: 8:15 p. m., third Monday of each month except June, July and August.

CLEVELAND ACADEMY OF MEDICINE, SECTION OF OPHTHALMOLOGY
AND OTOLARYNGOLOGY

Chairman: Dr. Webb Chamberlin, 7405 Detroit Ave., Cleveland.
Secretary: Dr. Walter H. Rieger, Hanna Bldg., Cleveland.
Place: Winton Hotel. Time: Fourth Friday of each month.

CLEVELAND OPHTHALMOLOGICAL CLUB

Chairman: Dr. Paul Moore, Republic Bldg., Cleveland.
Secretary: Dr. G. Leslie Miller, 14805 Detroit Ave., Cleveland.
Time: Second Tuesday in October, December, February and April.

COLLEGE OF PHYSICIANS, PHILADELPHIA, SECTION ON OPHTHALMOLOGY

Chairman: Dr. Charles R. Heed, 1205 Spruce St., Philadelphia.
 Clerk: Dr. Alexander G. Fewell, 1924 Pine St., Philadelphia.
 Time: Third Thursday of every month from October to April, inclusive.

COLUMBUS OPHTHALMOLOGICAL AND OTO-LARYNGOLOGICAL SOCIETY

Chairman: Dr. C. E. Silbernagle, 247 E. State St., Columbus, Ohio.
 Secretary-Treasurer: Dr. D. M. Johnson, 327 E. State St., Columbus, Ohio.
 Place: Deshler Wallick Hotel. Time: 6 p. m., first Monday of each month.

CORPUS CHRISTI EYE, EAR, NOSE AND THROAT SOCIETY

Chairman: Dr. Edgar G. Mathis, 416 Chaparral St., Corpus Christi, Texas.
 Secretary: Dr. E. King Gill, 416 Chaparral St., Corpus Christi, Texas.
 Time: Second Thursday of each month from October to May.

DALLAS ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. Lester H. Quinn, 4105 Live Oak, Dallas, Texas.
 Secretary: Dr. J. Dudley Singleton, 1719 Pacific Ave., Dallas, Texas.
 Place: Dallas Athletic Club. Time: 6:30 p. m., first Tuesday of each month from October to June. The November, January and March meetings are devoted to clinical work.

DES MOINES ACADEMY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

President: Dr. E. G. Linn, 604 Locust St., Des Moines, Iowa.
 Secretary-Treasurer: Dr. Grace Doane, 614 Bankers Trust Bldg., Des Moines, Iowa.
 Time: 7:45 p. m., third Monday of every month from September to May.

DETROIT OPHTHALMOLOGICAL CLUB

Chairman: Members rotate alphabetically.
 Secretary: Dr. William Fowler, 1424 Maccabee Bldg., Detroit.
 Time: 6:30 p. m., first Wednesday of each month.

EASTERN NEW YORK EYE, EAR, NOSE AND THROAT ASSOCIATION

President: Dr. J. D. Carroll, 102—3d St., Troy, N. Y.
 Secretary-Treasurer: Dr. Joseph L. Holohan, 330 State St., Albany.
 Time: Third Wednesday in October, November, March, April, May and June.

FORT WORTH EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. Van D. Rathgeber, 1012 Medical Arts Bldg., Fort Worth, Texas.
 Secretary-Treasurer: Dr. Charles R. Lees, 306 W. Broadway, Fort Worth, Texas.
 Place: Medical Hall, Medical Arts Bldg. Time: 7:30 p. m., first Friday of each month except July and August.

GRAND RAPIDS EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. Dewey R. Heetderks, 405 Medical Arts Bldg., Grand Rapids, Mich.
 Secretary-Treasurer: Dr. Robert G. Laird, 116 E. Fulton St., Grand Rapids, Mich.
 Place: Various local hospitals. Time: Third Thursday of alternating months, September to May.

HOUSTON ACADEMY OF MEDICINE, EYE, EAR, NOSE AND THROAT SECTION

President: Dr. L. Allen, 1215 Walker Ave., Houston, Texas.
 Secretary: Dr. George C. Farrish, 1625 Main St., Houston, Texas.
 Place: Medical Arts Bldg., Harris County Medical Society Rooms. Time: 8 p. m., second Thursday of each month from September to June.

INDIANAPOLIS OPHTHALMOLOGICAL AND OTOLARYNGOLOGICAL SOCIETY

President: Dr. C. P. Clark, 24 E. Ohio St., Indianapolis.

Secretary: Dr. Kenneth L. Craft, 23 E. Ohio St., Indianapolis.

Place: University Club. Time: 6:30 p. m., second Thursday of each month from October to May.

KANSAS CITY SOCIETY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. O. S. Gilliland, 1103 Grand Ave., Kansas City, Mo.

Secretary: Dr. John S. Knight, 1103 Grand Ave., Kansas City, Mo.

Time: Third Thursday of each month from September to May. The November, January and March meetings are devoted to clinical work.

LONG BEACH EYE, EAR, NOSE AND THROAT SOCIETY

Chairman: Dr. F. C. Hertzog, 117 E. 8th St., Long Beach, Calif.

Secretary-Treasurer: Dr. Ben K. Parks, 619 Professional Bldg., Long Beach, Calif.

Place: Professional Bldg. Time: Last Wednesday of each month from October to May.

LOS ANGELES SOCIETY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. Clifford B. Walker, 427 W. 5th St., Los Angeles.

Secretary-Treasurer: Dr. John P. Lordan, 2007 Wilshire Blvd., Los Angeles.

Place: Los Angeles County Medical Association Bldg., 1925 Wilshire Blvd. Time: 6:30 p. m., fourth Monday of each month from September to May, inclusive.

LOUISVILLE EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. J. S. Bumgardner, Heyburn Bldg., Louisville, Ky.

Secretary-Treasurer: Dr. Max Bornstein, Heyburn Bldg., Louisville, Ky.

Place: Brown Hotel. Time: 6:30 p. m., second Thursday of each month from September to May, inclusive.

MEDICAL SOCIETY OF THE DISTRICT OF COLUMBIA, SECTION OF
OPHTHALMOLOGY AND OTOLARYNGOLOGY

Chairman: Dr. Earle Breeding, 1801 I St., N. W., Washington.

Secretary: Dr. Elmer Shepherd, 1606-20th St., N. W., Washington.

Place: 1718 M St., N. W. Time: 8 p. m., third Friday of each month from October to April, inclusive.

MEMPHIS SOCIETY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

Chairman: Each member, in alphabetical order.

Secretary: Dr. Sam H. Sonders, Medical Arts Bldg., Memphis, Tenn.

Place: Eye Clinic of Memphis Eye, Ear, Nose and Throat Hospital. Time: 8 p. m., second Tuesday of each month.

MILWAUKEE OTO-OPHTHALMIC SOCIETY

President: Dr. Thomas A. Judge, 735 N. Water St., Milwaukee.

Secretary-Treasurer: Dr. John B. Hitz, 208 E. Wisconsin Ave., Milwaukee.

Place: University Club. Time: 6:30 p. m., second Tuesday of each month.

MINNEAPOLIS OPHTHALMOLOGICAL SOCIETY

Chairman: Each member, in alphabetical order.

Secretary: Dr. M. C. Pfunder, 645 Medical Arts Bldg., Minneapolis.

Place: Hennepin County Medical Society rooms. Time: 6:30 p. m., fourth Monday of each month, October to May, inclusive.

MONTGOMERY COUNTY MEDICAL SOCIETY

Chairman: Dr. A. G. Farmer, 1040 Fidelity Bldg., Dayton, O.

Secretary-Treasurer: Dr. Rome M. Webster, 663 Reibold Bldg., Dayton, O.

Place: Van Cleve Hotel. Time: 6:30 p. m., bimonthly, first Tuesday from October to June, inclusive.

MONTREAL OPHTHALMOLOGICAL SOCIETY

President: Dr. Stuart Ramsay, 1496 Mountain St., Montreal, Canada.
 Secretary: Dr. J. Rosenbaum, 1396 St. Catherine St., W., Montreal, Canada.
 Time: Second Thursday of October, December, February and April.

NASHVILLE ACADEMY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

Chairman: Dr. Guy Maness, 119-7th Ave., Nashville, Tenn.
 Secretary-Treasurer: Dr. Andrew Hollabaugh, Doctors Bldg., Nashville, Tenn.
 Place: St. Thomas Hospital. Time: 8 p. m., third Monday of each month from October to May.

NEW ORLEANS OPHTHALMOLOGICAL AND OTOLARYNGOLOGICAL SOCIETY

President: Dr. R. H. Fisher, Chess and Checker Club, New Orleans.
 Secretary-Treasurer: Dr. H. F. Brewster, 837 Gravier St., New Orleans.
 Place: Eye, Ear, Nose and Throat Hospital. Time: Third Thursday of each month from October to June.

NEW YORK ACADEMY OF MEDICINE, SECTION OF OPHTHALMOLOGY

Chairman: Dr. James W. White, 15 Park Ave., New York.
 Secretary: Dr. Rudolf Aebli, 30 E. 40th St., New York.
 Time: 8:30 p. m., third Monday of every month from October to May, inclusive.

NEW YORK SOCIETY FOR CLINICAL OPHTHALMOLOGY

President: Dr. Mark J. Schoenberg, 1160 Park Ave., New York.
 Secretary: Dr. Jesse Stark, 45 Park Ave., New York.
 Place: Squibb Hall, 745-5th Ave. Time: 7 p. m., first Monday of each month from October to May, inclusive.

OMAHA AND COUNCIL BLUFFS OPHTHALMOLOGICAL AND
 OTO-LARYNGOLOGICAL SOCIETY

President: Dr. A. J. Young, 107 S. 17th St., Omaha.
 Secretary-Treasurer: Dr. Delbert K. Judd, 1020 Medical Arts Bldg., Omaha.
 Place: Omaha Club, 20th and Douglas Sts., Omaha. Time: 6 p. m., dinner;
 7 p. m., program; third Wednesday of each month from October to May.

OPHTHALMOLOGICAL SOCIETY OF THE UNIVERSITY OF PITTSBURGH

President: Dr. W. W. Blair, 121 University Pl., Pittsburgh.
 Secretary: Dr. George H. Shuman, 351-5th Ave., Pittsburgh.
 Time: Second Monday in November, January, March and May.

PASSAIC-BERGEN OPHTHALMOLOGICAL CLUB

President: Dr. John S. Van Winkle, 297 Broadway, Paterson, N. J.
 Secretary-Treasurer: Dr. T. A. Sanfacon, 340 Park Ave., Paterson, N. J.
 Place: Paterson Eye and Ear Infirmary. Time: 9 p. m., last Friday of every month, except June, July and August.

PHILADELPHIA COUNTY MEDICAL SOCIETY, EYE SECTION

Chairman: Dr. Sidney L. Olsho, 235 S. 15th St., Philadelphia.
 Secretary: Dr. Edmund B. Spaeth, 1930 Chestnut St., Philadelphia.
 Time: First Thursday of each month from October to May.

PITTSBURGH OPHTHALMOLOGICAL SOCIETY

President: Dr. Glendon E. Curry, Westinghouse Bldg., Pittsburgh.
 Secretary: Dr. George H. Shuman, 351-5th Ave., Pittsburgh.
 Place: Pittsburgh Academy of Medicine Bldg. Time: Fourth Monday of each month, except June, July, August and September.

RICHMOND OPHTHALMOLOGICAL AND OTO-LARYNGOLOGICAL SOCIETY

President: Dr. N. H. Turner, 200 E. Franklin St., Richmond, Va.
 Secretary: Dr. Richard W. Vaughan, Medical Arts Bldg., Richmond, Va.
 Place: Westmoreland Club. Time: 6 p. m., second Monday of each month from October to May.

ROCHESTER EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. R. E. Elliott, 78 S. Fitzhugh St., Rochester, N. Y.
 Secretary-Treasurer: Dr. Raphael Farber, 280 Monroe Ave., Rochester, N. Y.
 Place: Rochester Medical Association, 113 Prince St. Time: 8 p. m., third
 Monday of each month from October to May.

ST. LOUIS OPHTHALMIC SOCIETY

President: Dr. Lawrence T. Post, 508 N. Grand Blvd., St. Louis.
 Secretary: Dr. Leslie Charles Drews, 508 N. Grand Blvd., St. Louis.
 Place: Oscar Johnson Institute. Time: Clinical meeting 5:30 p. m., dinner and
 scientific meeting 6:30 p. m., fourth Friday of each month from October to
 April, inclusive, except December.

SAN ANTONIO OPHTHALMOLO-OTO-LARYNGOLOGICAL SOCIETY

President: Dr. Oscar H. Judkins, 414 Navarro St., San Antonio, Texas.
 Secretary-Treasurer: Dr. Wilfred E. Muldoon, 414 Navarro St., San Antonio,
 Texas.
 Place: Bexar County Medical Library. Time: 8 p. m., first Tuesday of each
 month from October to May.

SAN FRANCISCO COUNTY MEDICAL SOCIETY, SECTION ON EYE,
EAR, NOSE AND THROAT

Chairman: Dr. Joseph W. Crawford, 490 Post St., San Francisco.
 Secretary: Dr. Russell Fletcher, 490 Post St., San Francisco.
 Place: Society's Bldg., 2180 Washington St., San Francisco. Time: Fourth
 Tuesday of every month except May, June, July and December.

SHREVEPORT EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. J. A. Wilkinson, Medical Arts Bldg., Shreveport, La.
 Secretary-Treasurer: Dr. W. L. Atkins, 940 Margaret Pl., Shreveport, La.
 Place: Shreveport Charity Hospital. Time: 7:30 p. m., first Monday of every
 month except July, August and September.

SPOKANE ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. Raymond A. Lower, 407 Riverside Ave., Spokane, Wash.
 Secretary: Dr. Louis A. Parsell, Paulsen Medical and Dental Bldg., Spokane,
 Wash.
 Place: Paulsen Medical and Dental Library. Time: 8 p. m., fourth Tuesday of
 each month except June, July and August.

SYRACUSE EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. Gordon D. Hoople, 110 Medical Arts Bldg., Syracuse, N. Y.
 Secretary-Treasurer: Dr. I. Herbert Katz, 212 Medical Arts Bldg., Syracuse,
 N. Y.
 Place: University Club. Time: First Tuesday of each month except June, July
 and August.

TORONTO ACADEMY OF MEDICINE, SECTION OF OPHTHALMOLOGY

Chairman: A. Lloyd Morgan, Medical Arts Bldg., Toronto, Canada.
 Secretary: Dr. W. R. F. Luke, Medical Arts Bldg., Toronto, Canada.
 Place: Academy of Medicine, 13 Queen's Pk. Time: First Monday of each
 month, November to April.

WASHINGTON, D. C., OPHTHALMOLOGICAL SOCIETY

President: Dr. G. Victor Simpson, 1710 Rhode Island Ave., N. W., Washington,
 D. C.
 Secretary-Treasurer: Dr. Frank D. Costenbader, 1726 I St., Washington, D. C.
 Place: Episcopal Eye, Ear and Throat Hospital. Time: 8 p. m., first Monday
 in November, January, March and May.

CHOROIDAL SCLEROSIS IN CORONARY ARTERIO-SCLEROSIS

REPORT OF A CASE

MARTIN COHEN, M.D.

NEW YORK

During the past fifteen years many articles have been published with the object of correlating vascular lesions of the eye with diseases of the kidney and of the brain and more rarely with diseases of the heart involving the coronary arteries and associated solely with sclerosis of the choroidal vessels. Before presentation of the report of a case of choroidal sclerosis associated with coronary arteriosclerosis, several facts pertaining to this subject will be mentioned.

Arteriosclerosis is a diversified condition in which whole vessels, or parts of them, may be involved, causing degenerative lesions in their surrounding tissues as well as in various organs, including the ocular structures. The cause of the uneven distribution of these lesions of the vascular walls is unknown. In arteriosclerosis the arteries, both large and small, are primarily involved, as distinguished from arteriolar sclerosis, which affects primarily the arterioles, causing essential hypertension.

Choroidal sclerosis is due mainly to sclerotic lesions in the arteries; the veins are rarely affected. The sclerotic process produces degenerative changes in the intervacular stroma and pigment epithelium, causing exposure of the choroidal vessels. The focal sclerosis is usually caused by arteriosclerosis, syphilis, myopia, retinitis pigmentosa or a local inflammatory lesion, but sometimes the cause is idiopathic.

The retinal vessels frequently course over the degenerated choroidal areas without giving any ophthalmoscopic evidence of arteriosclerosis, indicating merely a focal choroidal sclerosis. In cases of choroidal sclerosis it is impossible to differentiate ophthalmoscopically between arteries and veins.

The histologic picture and the changes in the fundus in this condition will be considered in the case report.

Read at the regular meeting of the Section of Ophthalmology of the New York Academy of Medicine, Nov. 15, 1937.

Arteriosclerosis may exist in any of the intra-ocular vessels without clinical evidence of its presence elsewhere in the body, or it may be present elsewhere in the body without giving rise to ophthalmoscopic signs. The presence of intra-ocular sclerosis is a definite aid in confirming a diagnosis of arteriosclerosis elsewhere in the body if other clinical evidence is present, while in the absence of such evidence and with the existence of arteriosclerosis in the eye, its presence elsewhere is probable.

Lesions of the fundus in cases of arteriosclerosis may be altered by certain general conditions, such as hypertension, nephritis and diabetes. When such conditions are present, the ophthalmoscopic signs of arteriosclerosis are markedly aggravated, and a differential diagnosis is impossible without a general physical examination.

In cases of arteriosclerosis hemorrhages and transudates, due to degeneration of the vascular walls, may appear in the fundus. Even in the absence of hypertension, these changes are frequently observed.

Long¹ has classified sclerotic lesions of the arteries into several distinct groups, including the arteriolar thickening associated with hypertension, the reparative thickening following toxic and infectious injury and the type of thickening which seems to result from senile involution, independent of any known toxin, virus or heightened blood pressure. This last type is the most puzzling and is called "decreascent" by Allbutt.

Ophüls² stated that old age alone is not the most essential causative factor of arteriosclerosis. He based his conclusion on the fact that arteriosclerosis, which is a patchy process, occurs often in the young and is frequently absent in the old, in whom arterial changes are likely to be diffuse.

The lesions of the fundus associated with cardiac disease are observed principally in cases of congenital cardiac disease in which there is cyanosis of the retina due to a secondary polycythemia and in cases of subacute bacterial endocarditis in which septic emboli and hemorrhages appear in the retina and conjunctiva. More rarely, aortic regurgitation pulsation phenomena are observed in the retinal vessels. In cases of coronary arteriosclerosis the ocular sclerosis, if present, is an associated sclerotic lesion and is not due to the accompanying myocarditis.

Altnow³ stated that in eighteen of twenty-six cases of cardiac disease some degree of choroidal sclerosis was visible with the ophthalmos-

1. Long, Esmond R.: The Development of Our Knowledge of Arteriosclerosis, in Cowdry, E. V.: *Arteriosclerosis*, New York, The Macmillan Company, 1933, p. 19.

2. Ophüls, William: The Pathogenesis of Arteriosclerosis, in Cowdry, E. V.: *Arteriosclerosis*, New York, The Macmillan Company, 1933, p. 249.

3. Altnow, Hugo: Changes in the Eyeground in Vascular Diseases and in Related Conditions, *Arch. Int. Med.* **40**:757 (Dec.) 1927.

scope and that in all but two instances it was associated with definite retinal arteriosclerosis. On the other hand, choroidal sclerosis was absent in thirty cases in which there was definite retinal arteriosclerosis.

Yater and Wagener⁴ reported on twenty-five cases of coronary sclerosis in which the diagnosis of a cardiac lesion was confirmed by autopsy. The fundi were normal in only two cases; in one other case sclerosis of the choroidal vessels only was present. In seven cases the changes in the fundi were classified as senile sclerosis of the retinal arteries; in ten they were classified as the retinal arteriosclerosis of hypertension and in five they were not classified.

I recently examined the fundi in twenty-six cases in which a diagnosis of coronary sclerosis was made in the service of Dr. Robert Halsey at the cardiac disease clinic of the New York Post-Graduate Medical School and Hospital. In only those cases in which there were definite ophthalmoscopic signs of sclerosis was the diagnosis considered positive. Electrocardiograms were made in all cases. All the patients had one or more attacks of angina. Nephritis was absent. The ages ranged from 32 to 67; six of the patients were over 60 years of age. Ten showed retinal arteriosclerosis, one presented choroidal sclerosis alone and fifteen showed no positive signs of ocular sclerosis. Hypertension was absent in all but seven cases and was apparently not the deciding clinical factor in this series.

No conclusions can be drawn from the number of cases observed, but studies will be continued in order to correlate, if possible, vascular ocular disease with coronary sclerosis.

REPORT OF CASE

History.—A. G., an American-born Jewish merchant aged 69 (April 1937), married and the father of four healthy children, had been under the care of his family physician, Dr. Henry S. Pascal, for twenty-five years.

The patient was intelligent and of a quiet disposition. He was short, slim and dark and had a large head, a barrel-shaped chest and kyphosis due to Paget's disease of thirty years' duration. An uncle on the paternal side suffered from the same disease. There was no history or signs of syphilis. The temporal veins were engorged and tortuous.

In 1920, at the age of 52, he first complained of shortness of breath and difficulty in breathing, but there was no pain in the region of the heart. Examination revealed a systolic murmur and enlargement of the heart. The urine was normal; the systolic blood pressure was 130, and the diastolic pressure, 70. The diagnosis made in 1920 was arteriosclerotic heart disease. Since then he had been constantly under the care of his physician and had never shown any signs of hypertension or renal disease. In 1926 he complained of a rectal disturbance. A mass was discovered in the rectum, which on biopsy proved to be a carcinoma. A radical

4. Yater, W. M., and Wagener, H. P.: Ophthalmoscopic Signs in Disease of the Heart, *Am. J. M. Sc.* **178**:105, 1929.

operation was performed, and recovery was uneventful. As his general condition did not improve, he was referred in 1927 to Dr. B. S. Oppenheimer for an examination of the heart. The diagnosis was Paget's disease, arteriosclerosis, enlargement of the heart and auricular fibrillation.

Since 1927 he had frequently visited his physician on account of difficulty in breathing. He never complained of anginal pains but had frequent attacks of edema of the eyelids and extremities, which were always relieved by the use of tincture of digitalis. His blood never showed any evidence of secondary anemia. From year to year he gradually grew weaker and the cardiac disease became more pronounced until in April 1937, when, attempting to stretch out his arms, he died. Permission was granted for a complete autopsy, including removal of the eyes. The autopsy was performed by Dr. James R. Lisa; the eyes were placed in solution of formaldehyde for future study.

Autopsy.—The immediate cause of death, which could explain its sudden character, was extremely acute degeneration of the myocardium without any evidence of acute coronary thrombosis. The arteriosclerotic changes in the body were limited in distribution but severe. The entire pulmonary arterial tree was affected by marked arteriosclerosis. Histologic examination showed calcification and fibrosis, but without associated cellular reaction. This apparently is an end-stage. The second site of arteriosclerosis was the coronary system. The superficial coronary arteries (fig. 5) were intensely sclerotic and of the pipestem type; in some areas there was narrowing of the lumen but without occlusion, either chronic or acute. There was curiously little scarring of the myocardium, and the intrinsic coronary arteries were normal. Widespread arteriosclerosis of the left auricle was present, the entire endocardium being involved, so that the inner wall resembled an egg shell, thin and friable. Histologic examination of this wall showed fibrosis of the endocardium and subendocardial areolar layer, with numerous small plaques of calcium. There was complete absence of a cellular reaction. The pulmonary veins of the neighboring area were normal. There were slight arteriosclerotic changes in the aorta. The arteries of the kidneys were normal. There was no evidence of hyperplasia of the small radicles of interlobular caliber, and the arterioles were normal. Histologic examination of the kidneys indicated that the condition was not essential hypertension. Gross examination of the brain showed perfectly normal arteries; histologic examination of these vessels was not made. The spleen showed moderate sclerosis of the central arteries quite compatible with the age period. The arteries of all the other organs were normal. The heart weighed 450 Gm.

A diagnosis was made of Paget's disease of the bone, acute myocardial degeneration and arteriosclerosis of the coronary arteries and aorta.

Ophthalmologic Examination.—The first ophthalmologic examination conducted by me was made in April 1927, and others were made at varying intervals until the patient's death. His chief complaint was poor vision. Vision in the right eye equaled 20/20 with a plus 1 diopter sphere. External examination and functional tests showed nothing abnormal. Examination revealed the fundus to be of the tessellated type, affording visibility of the choroidal vessels. The disk and retinal vessels appeared to be normal. Several grayish dots, the size of a pinhead, were localized on the temporal side in the equatorial area. There was a slight pallor in the macular area. Vision in the left eye equaled 20/200 with a plus 1 diopter sphere. External examination and functional tests gave negative results. The fundus was of the tessellated type. The disk and retinal vessels were normal. About one-half disk diameter from the disk in its temporal area could be seen a

large ill defined elliptic and partially atrophic choroidal patch with a small hemorrhage, the size of a pinhead, in its superior and temporal border. This patch had a mottled appearance; its upper border invaded the macular area, and a few normal retinal vessels traversed its surface.

After this examination the patient returned at infrequent intervals until his death. The intermediate stages of the progression of the changes in the fundi will not be described, with the exception of an incipient choroidal atrophy in the macular area of the right eye in 1930, which gradually reduced the vision to 20/200

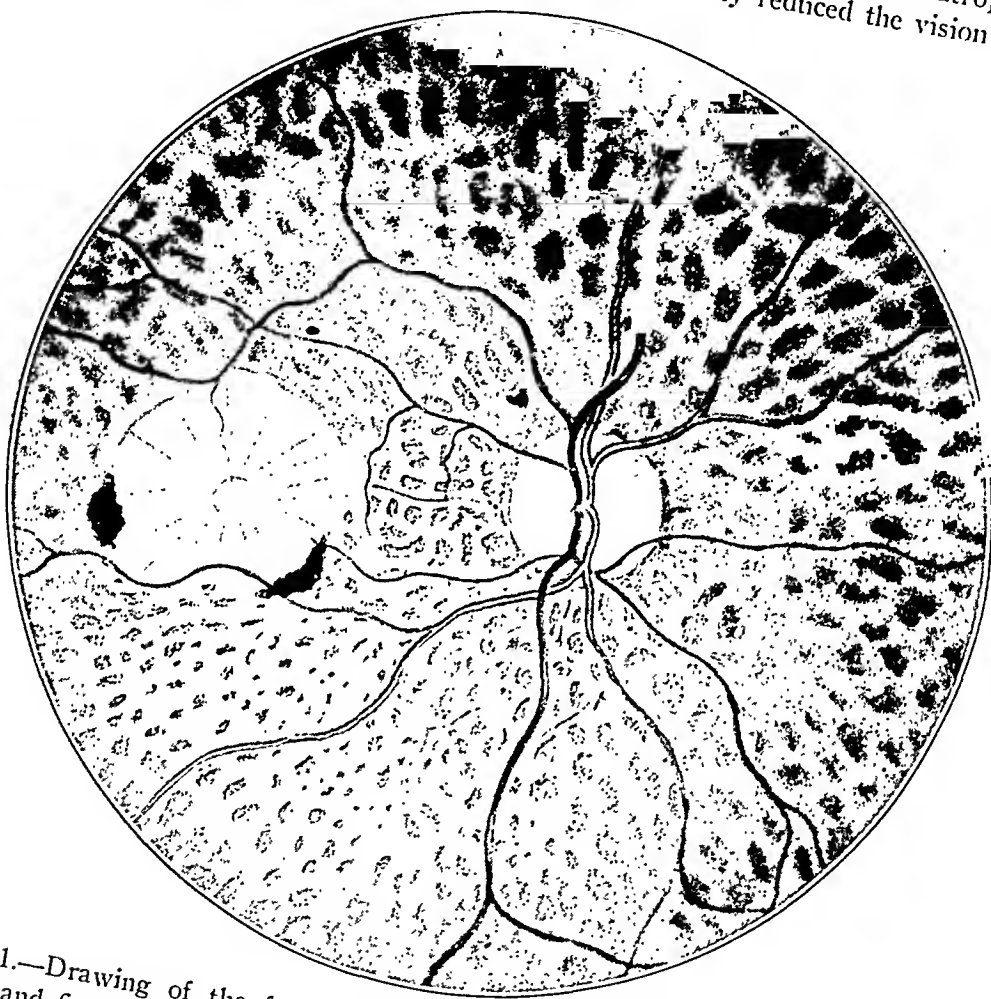


Fig. 1.—Drawing of the fundus of the left eye, showing localized choroidal sclerosis and fine canalization of some vessels.

with a lens correction. In the left eye the vision was reduced to counting of fingers. The bilateral choroidal degeneration gradually increased in all directions, but especially in the left eye, reducing the vision in each eye to perception of objects at 1 foot (30 cm.) in 1936.

A drawing of the fundus of the left eye (fig. 1) was made two months prior to the patient's death. The right eye showed a similar lesion, with the exception of the marked choroidal atrophy in the macular area. At that time the fundus of the left eye was of the tessellated type. The optic disk appeared normal, as did the retinal vessels over the entire retina, including the choroidal patch. Starting from the temporal margin of the disk, a large ill defined and atrophic choroidal patch extended downward and to the macular area. The patch had a mottled

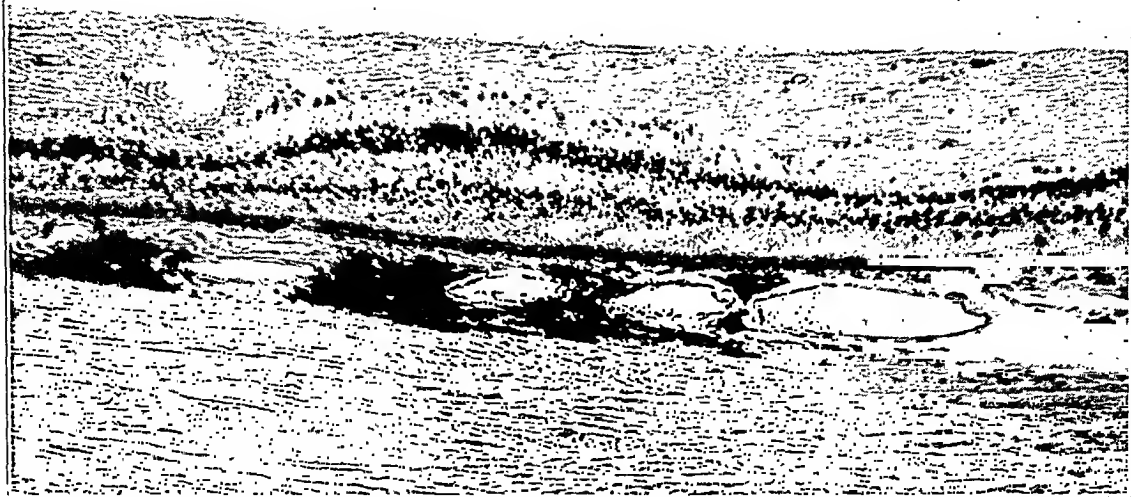


Fig. 2.—Section of the area which clinically demonstrated choroidal sclerosis; $\times 120$. Note the atrophy of the choroid and the relative fibrosis of the arterial walls without any marked thickening or encroachment on the lumens of the vessels.

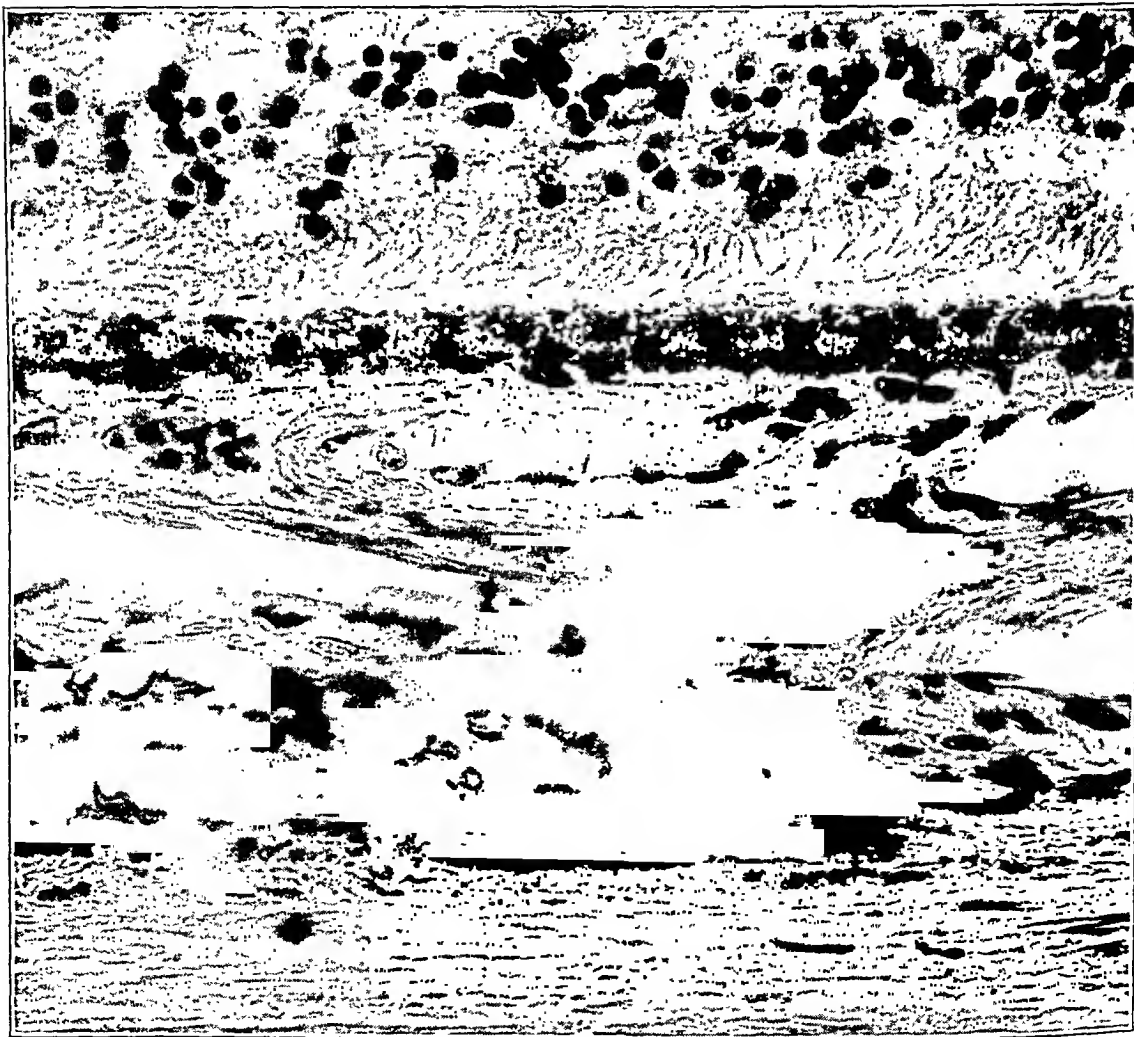


Fig. 3.—A choroidal artery seen in figure 2, showing the fibrotic wall without narrowing of its lumen; $\times 240$.

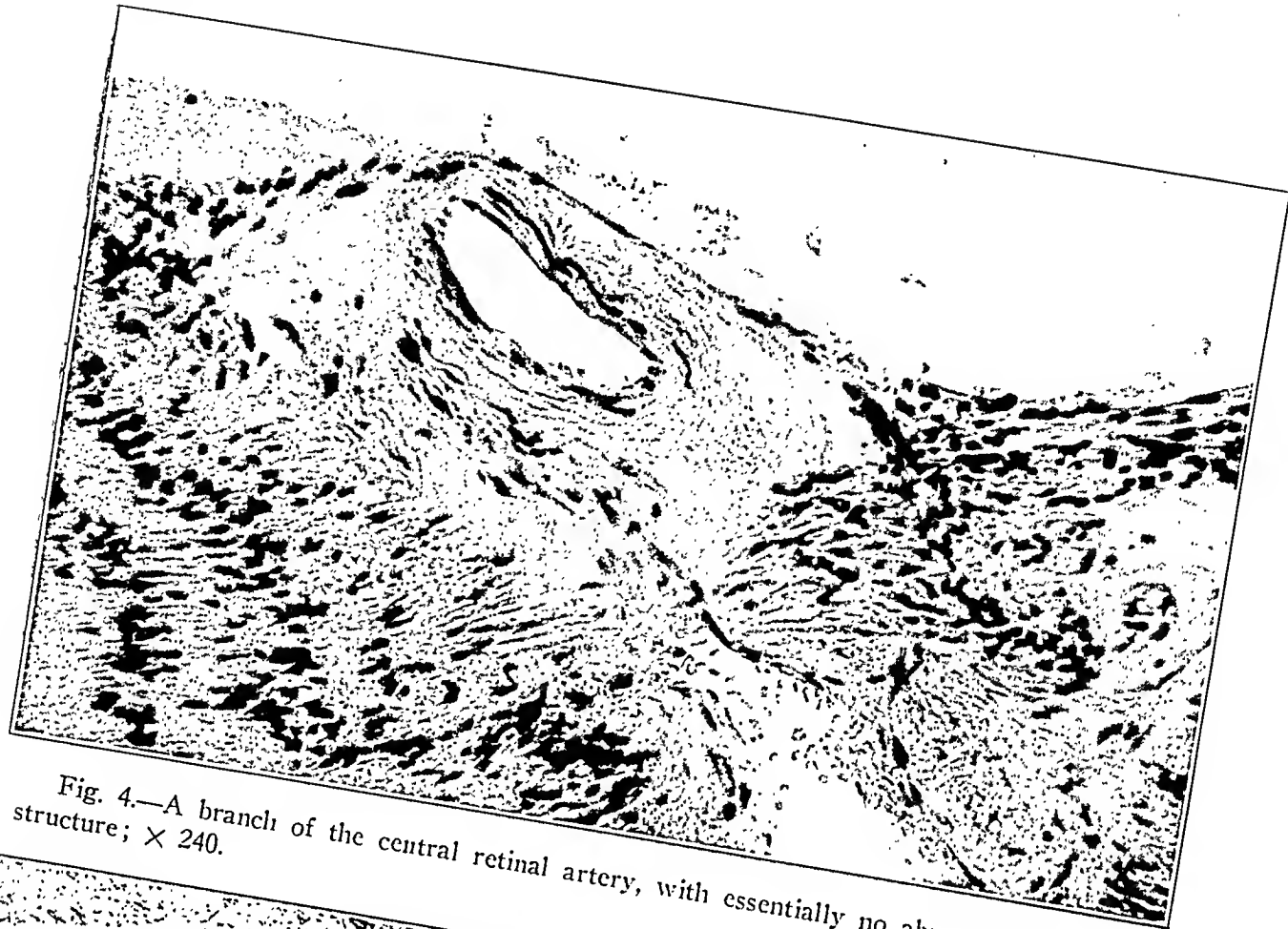


Fig. 4.—A branch of the central retinal artery, with essentially no abnormalities in its structure; $\times 240$.

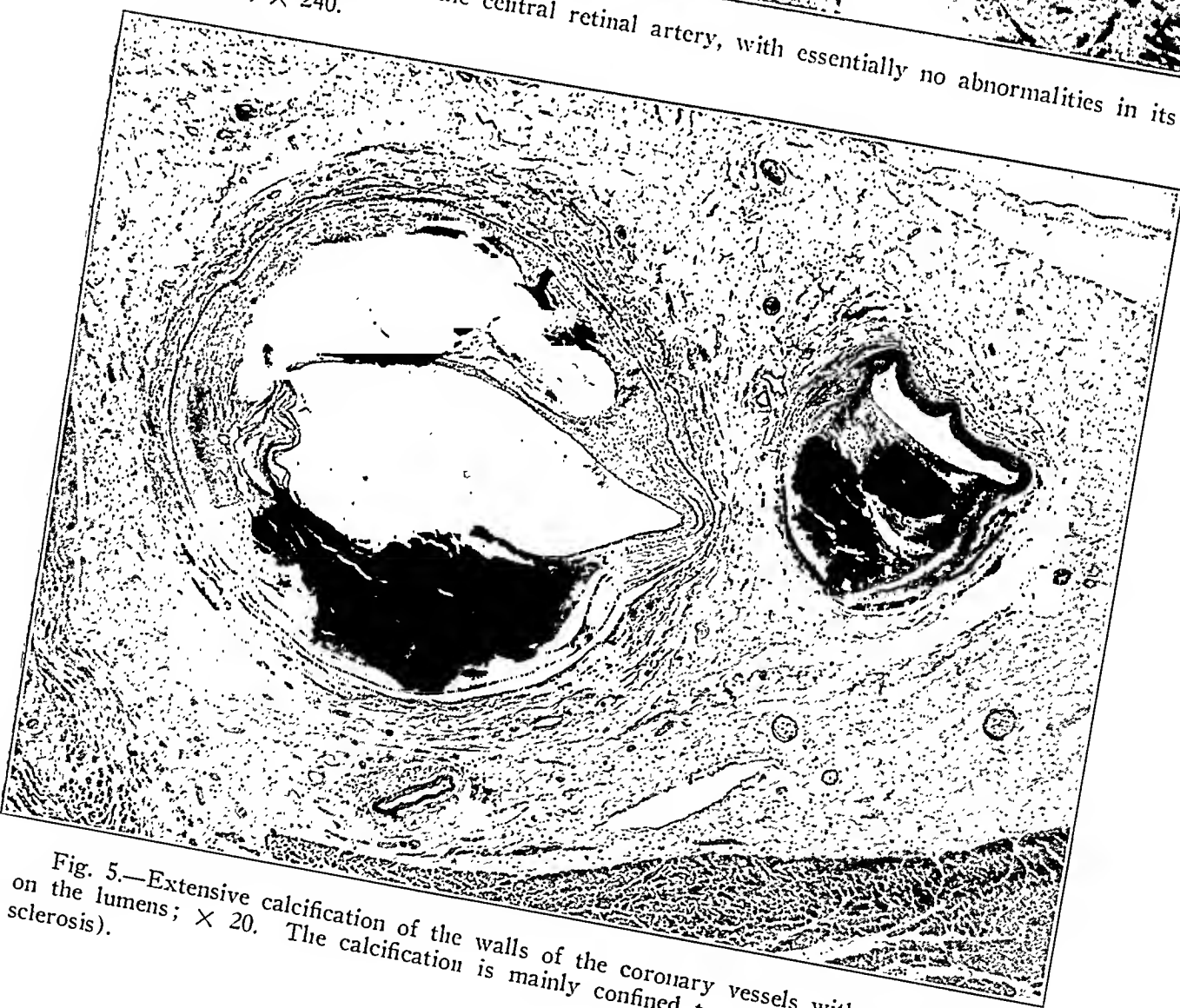


Fig. 5.—Extensive calcification of the walls of the coronary vessels with encroachment on the lumens; $\times 20$. The calcification is mainly confined to the media (Mönckeberg's sclerosis).

appearance due to the anastomosis of the choroidal vessels, which appeared as narrow whitish bands, in some of which a fine red line was visible in the lumen, indicating circulation, while in most of the vessels no lumen could be recognized. The intervacular stroma was slightly pigmented. In the macular region was a whitish circular area one-third larger than the disk, in the center of which was a blackish dot in the fovea, with many fine blackish lines radiating from it. The white patch was the site of an earlier large circular hemorrhage, which after a month was gradually resorbed, leaving scar tissue.

A diagnosis was made of bilateral focal choroidal sclerosis without evidence of retinal arteriosclerosis.

The ocular lesion in the left eye had been in existence for some time previous to my first examination. On the other hand, the one in the right eye developed and progressed during the period of my observation (nine years), beginning, therefore, eleven years after the first evidence of cardiac disease. From this fact it might be inferred that the choroidal sclerosis of the right eye was a condition associated with, and not independent of, the coronary sclerosis.

Histopathologic Report.—Both eyes were examined. Serial sections of the left eye were prepared and then studied with various stains. The cornea, lens and media were normal. The iris was normal in structure; the iritic arteries were thick walled but showed no degenerative changes. The retina was normal. The pigment epithelium showed on the temporal side of the retina small areas of depigmentation, beneath which the choroid was thin and atrophic. The epithelium was markedly deficient in pigment, although at the peripheries of the areas the pigment was very dense. In the areas of depigmentation (fig. 2) the intervacular stroma appeared condensed and relatively increased in amount, merging at the periphery with the more normal intervacular stroma of the adjacent areas. The walls of the arteries in the depigmented areas were somewhat changed from normal; the thickness was not altered, but the muscular coat was replaced by fibrosis, which was quite acellular (fig. 3). The elastica stained rather poorly. The endothelium was preserved. The lumen was normal. In the more normal portion of the choroid the thickness was somewhat diminished, but the arteries in these regions had a perfectly preserved pattern. The internal elastica was clear, stained sharply and was not split. The muscular coat was well preserved, and many of the muscular nuclei were quite distinct. The optic nerve was normal, as were the central artery (fig. 4) and vein and the vessels surrounding the head of the optic nerve. The arteries in the dural sheath of the nerve showed thickened walls. An occasional very small plaque of calcification was found in the sclera.

COMMENT

The only changes seen in the eyes histologically were limited to the focal area of the choroid, on the temporal side only. They consisted of depigmentation, relative fibrosis and atrophy of the choroid and sclerosis of the choroidal arteries. These changes resembled purely degenerative lesions of the muscular coats, without alteration of the thickness of the walls or encroachment on the lumens, and differed from the hyperplastic changes in the vascular walls observed in cases of essential hypertension and chronic glomerular nephritis.

Dr. Henry S. Pascal supplied me with the history of the patient.

DISCUSSION

DR. JAMES R. LISA: This case is of extraordinary interest because it is seldom that one can perform a complete autopsy and check the histologic changes in the eyes with the results of preceding ophthalmoscopic examinations. A point of interest is that the change which one would ordinarily expect to see in the eyes was not present. The most frequent change, of course, is that described by Dr. Cohen—hyperplastic change associated with hypertension or with glomerulitis. In the case reported here the lesions apparently were of the purely degenerative type, with little change in the lumens of the arteries. A second point of interest is the focal localization. There was no evidence of any inflammatory lesion in the eye. This brings up the question of the relation of inflammation to degenerative focal lesions in the eye. Any highly specialized organ is extremely susceptible to degenerative changes, and one of the most highly specialized organs, of course, is the brain. Since the eye is an outpouch it can be considered as part of the brain. Some years ago Dr. Pike, in doing some experimental work on the vascular supply of the brain, studied the changes which occurred in the neurons when the vascular supply was cut down for short periods of time, and it was shown by his work that occlusion for a few seconds would cause degenerative lesions that were visible under the microscope. This raises the question whether the moderate degenerative lesions occurring in the arteries in this case could have been the basis of the changes visible in the eye. The change in the vascular walls was fibrotic, and naturally that means a loss of elasticity. It is possible, therefore, that loss of elasticity could so interfere with the proper function, or proper nutrition, of the eye, as to lead to focal patches of sclerosis, such as those seen in this case. The relation of choroidal sclerosis to coronary arteriosclerosis is a point of interest, but one on which one cannot take a definite stand. In this case the arteriosclerosis of the coronary arteries was very intense and led to the type of cardiac dysfunction usually seen in such cases. This again illustrates the fact that sclerosis is not necessarily a generalized condition. As a matter of fact, generalized arteriosclerosis is a poor term, because it is misleading. In this case the most intense sclerosis was in the coronary arteries. The sclerosis was also intense in the pulmonary arteries, but to a less extent, and was moderate in the aorta. It was focal in the eye, and even here it was limited to a small highly specialized part. Examination of the kidneys in this case probably indicated why hypertension was not found; they were normal, with no changes in the large vessels, and the arterioles were normal.

DR. ROBERT H. HALSEY: I think that the fact should be kept in mind that when the coronary arteries are involved there may be some disturbance in other parts of the body without there necessarily being any relation between the two in the sense that because disease of the coronary artery is present there may therefore be a similar disease elsewhere in the body. In this particular case I think that it is interesting that there was such an intense coronary disease, and yet coronary thrombosis apparently did not occur, or at least it was not mentioned. I assume that it was not present. Auricular fibrillation was reported, and I think that with the swelling of the face and ankles which was present it is quite possible that there was a prolonged congestive

condition of the base of the lungs, and possibly in other parts of the body. The pulmonary circulation undoubtedly was greatly impaired. I think that this is a most interesting study that Dr. Cohen has been making of the relation, if one may say so, between coronary thrombosis and the condition of the eye. In general, I believe, he found some arteriosclerosis in the eye in about 40 per cent of cases of definite coronary thrombosis. In the other 60 per cent there was possibly no such evidence. I think that it will be interesting to continue the study and to find out the usual percentage and relation of the two conditions. I think that one should stop with stating the facts and not try to infer that a relation exists.

DR. ADOLPH POSNER: It is not clear to me what made Dr. Cohen associate the two conditions—the coronary sclerosis and the choroidal sclerosis—other than the presence of the one incidental to the other.

DR. MARTIN COHEN: I think that I stated in the paper that the condition in the right eye was observed about nine years after the symptoms of cardiac disease. The patient first showed some macular pallor, which gradually developed into evidence of sclerosis of the choroidal vessels. He was observed for eight or nine years, so that I saw him before choroidal sclerosis began. I saw him when the coronary disease had already developed and naturally would infer from that that it was an associated, and not an independent, condition. I cannot say positively that the conditions were not independent, but my inference would be that they were not.

PYRETOTHERAPY IN OPHTHALMOLOGY

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Although the therapeutic use of induced fever has attracted the eager attention of ophthalmologists, it is certain that it is far from having entered into the current domain of ophthalmology. Works treating the question are still rare, especially in French-speaking countries. Among the authors who have occupied themselves with this matter may be cited: in Belgium, J. Francois; in France, J. P. Carlotti, A. Gault, D. Paulian, S. Schiff-Wertheimer and H. Viallefont; in the United States, W. L. Benedict, G. P. Clark, A. M. Culler and W. M. Simpson, P. O'Leary and A. L. Welsh, C. Weskamp, and E. L. Whitney; in Italy, A. Ferrari, Livio-Pratti, G. Roasenda, Sabbadini; and G. Tirelli; in Rumania, L. Winkler; in Germany, C. Behr, Fischer and Ascher, B. Fleischer, Gasteiger, R. Hessberg, Igersheimer, E. Weinberg, and J. Wolff, in Austria, Wagner-Jauregg, and in Japan, K. Ohyama.

Before indicating the pyretogenic processes that are made use of in ocular therapeutics, with the results that one can obtain, it is necessary to insist on the essential difference which exists between pyretotherapy and the therapeutics of shock, especially because the two methods are often mistaken for one another and one often hears that the therapeutics of shock is particularly employed in ophthalmology. In fact, the great majority of ophthalmologists—I would almost say all—have recourse to medication by shock. The methods are varied; the one most employed is, without doubt, parenteral injection of milk. Certainly, in many instances shock is accompanied by thermal modifications and is therefore more or less pyretotherapeutic. But shock has three characteristics: collapse of the nervous system, arterial hypotension and leukopenia. Moreover, in the patients in whom one has caused shock one always notices sudden modifications of the blood plasma, and incoagulability of the blood. These do not occur in the patient treated by pyretotherapy, for whom hyperthermia is especially sought. Pyretotherapy is treatment by fever. The fever brings modifications in the organism which are capable of bringing about the cure of the malady. It cures by its simple existence, either by making the habitual therapeutic agents more active or by causing the organism to

be more receptive to these agents. With a great deal of reason, C. Richet and A. Meyer-Heine said: "Shock is one thing; pyretotherapy is another." Besides, therapeutic shock can bring about an appreciable result without being accompanied by the slightest increase of temperature, and often there is a difference between the thermal reaction and the therapeutic effect.

The principal pyretogenic agents employed in ophthalmology are: malariotherapy, dmelcos, pyrifer, sulfur in oil, the Kettering hypertherm and short waves.

I. MALARIO THERAPY

The excellent results obtained by inoculation with the organisms of malaria in cases of dementia paralytica necessarily inclined ophthalmologists to try it in cases of syphilitic disease of the eye, particularly of atrophy of the optic nerve.

From a practical point of view, it may be recalled that one should always be careful to inoculate *Plasmodium vivax*, the parasite of benign tertian ague, and not *Plasmodium falciparum* or the parasite of the quartan fever, which might cause serious or even fatal accidents.

The donor should not be a native of a paludal or colonial region. One can well make use of a stock that has been tested and that one can transmit from one patient to another.

One takes from the bend of the elbow a sufficient quantity of blood to be injected, an average of 3 cc. For this purpose one uses a needle mounted on a syringe. It is not necessary to take the blood at the time of the acme of a febrile attack. The method of inoculation is generally the subcutaneous one. After the blood is in the syringe, one injects it, with the same needle, under the skin at the level of the subscapular region of the abdomen, at no matter what site. Certain authors, among them Rademaekers, Rodríguez Arias and Paulian, prefer the intravenous method, as they believe that it is more sure, and with this method the period of incubation is shorter. The period of incubation generally passes without incident. It lasts from eight to twelve days after inoculation by the subcutaneous method and from six to eight days when one has made use of the intravenous method. It is also necessary to know that it is shorter in summer, especially at the commencement of this season, and that it is longer at the end of autumn and in winter.

The evolution of paludism is variable. The thermal oscillations are at first irregular. After three or four days they become more regular. The temperature then attains 40.5 C. (105 F.) or even 41 C. (106 F.) and drops to 37 C. (98.6 F.) when the attack has passed.

During the period of the attack it is necessary to watch the patient attentively. One takes the temperature three times a day; one must

watch the pulse rate and the arterial pressure and must note the amount of urine, marked oliguria necessitating suspension of the attacks.

On an average, one allows eight or ten attacks to develop. In reality, this number is variable; it depends on the age of the subject, on his tolerance and on his previous condition. With feeble persons one can carry out the treatment in two series. In that case one stops the treatment after four attacks, reinoculates with malaria at the end of a month and stops the treatment again after four more febrile attacks.

One interrupts the attacks by giving, during three or four days, 1.5 Gm. of quinine sulfate, in three doses. The action of the quinine is evident; all the authors have agreed that quinine is much more active in provoked malaria than in malaria resulting from the bite of a mosquito.

The accidents from the methods should be known. Some authors have mentioned mortal accidents in from 3 to 5 per cent of the cases. P. Savy expressed the belief that malariotherapy causes, on an average, a mortality of 10 per cent. Cardiac collapse represents the most serious complication. It may occur in the course of a hyperthermic crisis, or it may develop suddenly or progressively outside the state of hyperthermia. This explains how important it is to watch the pulse rate and the arterial tension. A maximum tension of 9 should cause one to stop the treatment immediately. As major accidents it is necessary to mention acute hepatic deficiency accompanied by serious icterus, hemorrhagiparous syndromes (hemorrhages affecting the kidneys, the intestines or the brain), and rupture of the spleen, always fatal. As benign accidents may be mentioned cutaneous lesions, in particular herpes, the frequency of which is still much debated.

The enumeration of these complications permits of establishing the conditions necessary in treatment with malaria. A relatively good general condition, no grave impairment of circulation and absence of damage to the kidneys and liver are required. Pulmonary tuberculosis constitutes a strict contraindication, as do marked arterial hypotension, obesity in a patient with a large heart, cardiac decompensation and aortic aneurysm. Let me say again that it is necessary to be doubly prudent in cases of extrasystole, of permanent arrhythmia, of hypertension and of contraction of the mitral valve, because these are conditions in which the patient is always exposed to danger. It is recommended that patients who have passed their sixtieth year should not be inoculated.

Many authors are of the opinion that malarial inoculation can be utilized during pregnancy. In general, it would not cause miscarriage. The child may live if its paludism is treated as soon as it is born.

The treatment should be carried out in an institution or in a hospital. There it would be possible to establish the indispensable observation and immediately apply the necessary treatment if the slightest complication supervened. Sojourn at an institution is also indicated from a

social point of view, because it has been proved that a patient inoculated with malaria can infect anopheles that would transmit the malaria.

It is also necessary to know that malariotherapy is a most depressing treatment. Vomiting often accompanies febrile attacks. Nearly always there is anorexia, which may be complete. Therefore, great fatigue and marked wasting away will result from the treatment.

Among the first ophthalmologists to treat syphilitic atrophy of the optic nerve with malaria one must mention de Behr and Henson. Their example has been quickly followed by others. But if one studies the results which have been published, one is struck by the little agreement that one finds. Some authors have proclaimed that the method is marvelous and that it will bring about real amelioration. Some have expressed the opinion that it succeeds only in stabilizing the illness. Finally, others have condemned it, saying that it is dangerous and that it may result in grave catastrophes.

In order to be able to have a more or less exact idea of the value of malariotherapy in cases of syphilitic atrophy of the optic nerve I have divided into three groups the various authors who, to my knowledge, have occupied themselves with the question, according to whether they have observed amelioration, maintenance of the status quo or aggravation.

In the first group, among those who have seen improvement resulting from this treatment are: Fischer and Ascher, who observed amelioration in one of eighteen cases; Artwisky and Ostrewski, who noted amelioration in one of nine cases, and Sabbadini, who observed it in three of six cases in six years. Carlo Gorla, Leroy, Medakovitch and Prieur also declared that the visual keenness may be heightened. Lassale, Sonier and Anjalu have seen vision become better in one case. Wagner-Jauregg also spoke of a slight improvement in vision. D. Paulian saw improvement in two of twenty-nine cases. G. P. Clark, who studied fifty patients with dementia paralytica, stated that the visual acuteness improved in thirteen. Fleischer has also noted that vision improved. Charles Weskamp has observed amelioration in eight of sixteen cases.

In the second group I include all those who have noted stabilization, or maintenance, of vision after this form of treatment. It is fitting to cite here all those who have reported amelioration, for in their works they have mentioned also patients whose vision has been stabilized. Thus, Fischer and Ascher pointed out that in their eighteen cases the vision existing before the treatment was preserved, and Paulian considered that in half the cases observed by him the evolution of the ocular condition was stopped. Fleischer mentioned eight cases in which visual acuteness had been stabilized, one of which he had observed for eight years. Wild Margareth noted arrest of the atrophy of the

optic nerve in four of five cases, Wolff in five of twelve cases and Marinesco in five of ten cases. Suzanne Schiff-Wertheimer stated that Arruga declared that he had noted stabilization of the ocular condition in two of six patients. J. Chaillous noted maintenance of vision during five years in three cases and during two years in one case. Pensitur and Orzechewski have also ascertained that one can check the atrophy of the optic nerve. Heinsius mentioned a patient who had been treated during the previous eight years and in whom the ocular condition remained stationary.

In the third group, which consists of the adversaries, may be cited C. Behr, who deems that the method is a bad one. Igersheimer, Beyer, Kehrer and Ringe have shared the same view and have insisted on the dangers of this treatment for vision. O'Leary stated that he saw aggravations in seven of nine cases. Gasteiger said that he saw visual acuity diminish in fifteen of twenty-one cases, and in eight of these the lowering of vision was particularly rapid, occurring immediately after the treatment. He expressed the opinion that malariotherapy should be abandoned in view of the possibility and even the probability of detriment to the patient.

What conclusions can be drawn from all these observations?

It may be stated first that all the adversaries of malariotherapy in cases of optic atrophy, those who judge that it is a dangerous technic which causes aggravations, are in the minority in comparison with those who praise its effects. It is true that one is always more inclined to describe the happy results of a new therapy than to describe the failures. It would therefore seem that in a great number of cases the introduction of the malaria organisms stabilized the condition. I shall not speak of improvement. If there is any, all the better.

To bring about this stabilization it is absolutely necessary to treat the disease at the beginning. That is a point on which one cannot insist enough. Wagner-Jauregg also recommended attenuated malarialization, so that the temperature will not go higher than 40 C. (104 F.), because high pyrexia may have a bad influence on the optic nerve. In this respect he is an advocate of the process of Horn and Kauders, who administer 0.05 Gm. of quinine every two days during the period of incubation and the same dose every day as soon as the attacks are established. But Suzanne Schiff-Wertheimer has expressed doubt whether the prolonged use of quinine, even in small doses, might not interfere with the circulation of the optic nerve, the more so because the nerve is ill. She therefore insisted that the ophthalmoscopic examination be made so as to show the papillary vessels. Creuzon, however, does not think that the quinine treatment can have an influence on the optic nerve, for the good reason that he has never met with ocular complications in patients given small doses of quinine.

The treatment appears to succeed better if other therapeutic means have not been previously tried, and malariotherapy should be followed by chemotherapy. One month and a half after inoculation with the organisms of paludism one commences antisyphilitic treatment, generally on a basis of arsenic, with bismuth. Even mercury has been employed. Chemotherapy should always be prolonged.

All the authors are agreed that dementia paralytica benefits much more from the malariotherapy than tabes does. This must explain the improvement obtained in an impressive proportion of cases of atrophy of the optic nerve that one learns of from certain statistics. G. P. Clark, as I have already said, mentioned improvement in thirteen of fifty cases. But these were cases of dementia paralytica. The same is true for pupillary signs. Among these fifty cases of dementia paralytica, Clark noted disappearance of bilateral Argyll Robertson's sign in twenty-two and disappearance of unilateral Argyll Robertson's sign in six. Among seventy-two patients with dementia paralytica with fixed pupils who were subjected to malariotherapy, K. Ohyama noted ten in whom the photomotor reflex was reestablished, while it is admitted that the pupillary symptoms of tabes are rarely modified by the malaria treatment. One must, however, mention that Leroy, Medakovitch and Prieur have seen reappearance of the photomotor reflex after malaria treatment has been given to a patient with tabes.

Inoculation with malaria organisms has been applied also in the treatment of parenchymatous keratitis—in smaller numbers of cases. it is true, because it is recommended that it not be used for children under 12 years of age. In children below that age attacks of paludism are badly tolerated.

J. Amblèr and J. Van Cleve praised the results of malaria therapy in this condition, which are superior to those obtained by the ordinary antisyphilitic treatments. They stressed particularly the rapid disappearance of pain, weeping and photophobia and the resorption of the corneal opacities. Among seventeen cases, the injury remained unilateral in five.

But Irena Mrazova has been less enthusiastic. This author expressed the opinion that even if the subjective and objective signs diminish they reappear later, with greater intensity. Among twelve cases, improvement was evident in only two. Recurrences were not avoided, and the prophylactic effect was nil.

Kuborn treated four patients; it was not possible for him to express an opinion.

II. DMELCOS

Inaugurated in 1928 by Sicard, Hagueneau and Wallich as a pyretogenic agent, the antichancroidal vaccine of Nicolle, called dmelcos, is a stabilized emulsion of the Ducrey bacilli from several stocks, at a titer of 225 million micro-organisms per cubic centimeter. It is dis-

tributed in ampules containing 225, 335, 450, 550 or 675 million bacilli. It is injected by the intravenous method, and the dose varies. It is necessary that a sufficiently high temperature be attained; it should rise to from 39 to 40 C. (102 to 104 F.). "One must not employ," wrote Milian, "too feeble doses or leave too long intervals between the injections." It is recommended that one commence with extreme prudence, by injecting 0.5 cc.. This dose often causes sufficient elevation of temperature. If it does not, one may progressively increase the dose 0.5 cc. at a time, up to 4 or 5 cc. if necessary. When the optimum dose is reached, one stops. There is no reason for increasing the dose when the thermal elevation is sufficient. It sometimes happens that the reaction diminishes with later injections. It is then necessary to use stronger doses, always increasing the amount by 0.5 cc. at a time. The contrary may also happen. In these circumstances it is evident that one must diminish the quantity.

According to Sicard, one may give two or three injections a week. The injection may be repeated up to eighteen or twenty times. The period of incubation is about the same for each patient. Generally, two or three hours after the injection the patient suffers from a general feeling of discomfort, with a sensation of cold. At the same time intense shivering starts, which is of the pseudomalarial type. The shivering may be accompanied by nausea and vomiting. It is sometimes painful. The temperature increases at the same time up to 39 or 40 C. The pulse is accelerated, but the arterial tension is not lowered. The increase of temperature attains its acme at the end of five or six hours. A sudoral attack then comes on, and the temperature rapidly drops. In every case the temperature always becomes normal the following day.

The great advantage of dmelcos is that it is easy to administer and permits of provoking fever at will. It is generally well tolerated and does not lead to anorexia or violent shock.

It is, however, recommended that it should not be used for elderly persons, tuberculous persons, persons with cardiac or nephritic conditions or patients who suffer from phlebitis or aneurysm. In fact, these conditions are the general contraindications to all pyretotherapeutic methods.

In cases of syphilis it is necessary to combine the antisyphilitic treatment with dmelcos. To this end several authors have used sulfarsphenamine or tryparsamide, which they injected by the intravenous method immediately after injection of the antichancroidal vaccine.

Among the first essays on dmelcos therapy in ophthalmology, one must mention a work by H. Viallefont, who in 1928 applied the method with success in a case of traumatic keratitis complicated by iritis. The patient was nonsyphilitic; acetylsalicylic acid and sodium salicylate had

been of no use. The second day after only one injection, which caused the temperature to go up to 39 C., the patient went back to work, with a normal eye.

Carlotti has used dmelcos for different disorders. Often he has given it in association with propidon (a mixed stock vaccine prepared by the method of P. Delbet) which he injects first. Sometimes he has followed the injection of dmelcos by an injection of sulfur in oil. He uses thus, as he said, the whole pyretogenic scale, not confining himself to one product. He leaves an interval of two days between the injection of propidon and that of dmelcos, and four days between the consecutive injections of sulfur in oil.

He has treated numerous patients with trachoma by this method. In cases in which the disease was acute, this author wrote, pyretotherapy has acted effectively, and in cases in which there were complications its help not only has been certain but appears to be preponderant.

This author has also noted good effects in cases of conjunctivitis caused by the bacillus of Weeks and by that of Morax, as well as in those in which the disease was due to the gonococcus. It is in this condition that he believes that he has obtained the best results. He mentioned a case of gonococcic conjunctivitis in a patient of 25 years, who was completely cured, without any local treatment, after injections of propidon and of dmelcos.

The corneal ulcers treated by Carlotti were also benefited by this method. The pain disappears first.

He also praised dmelcos for the results obtained in cases of interstitial keratitis, in which the infiltration has always been remarkably influenced by this agent. He has never seen the second eye encroached on during pyretotherapeutic treatment.

Magitot was willing to give statistics concerning twenty-six patients whom he treated by means of the antichancroidal vaccine of Nicolle. In fifteen of these patients he injected only dmelcos, in addition to the local treatment, and in the other eleven he combined this treatment with injections of milk, of propidon and of sodium hyposulfite.

Among the patients who were treated only with dmelcos, there were one with an infected dermoid cyst, one with neuroretinitis of unknown cause, one with follicular conjunctivitis associated with grave adenopathy, five with iritis and iridocyclitis, two with postoperative infections and five with keratitis.

Dmelcos gave a marked result in the case of the infected dermoid cyst. It had no effect on the neuroretinitis or on the conjunctivitis associated with adenopathy. In four of the five patients with iritis and

iridocyclitis the conditions were happily influenced, as were the post-operative infections, and the keratitis, in three of the five patients with this condition.

These statistics demonstrate that dmelcos therapy is particularly useful in cases of iritis, iridocyclitis and postoperative infections. The same conclusion has been drawn from the results in cases in which injections of dmelcos have been combined with those of milk, of propidon and of sodium hyposulfite.

Mention may also be made of the observations of A. Gault in two cases of spasm of the central artery of the retina, which yielded to treatment with injections of dmelcos combined with injections of acetylcholine hydrochloride when treatment with the vasodilator alone had given no result.

III. PYRIFER

This produce is a nonspecific protein mixture prepared with extracts of fever-producing bacteria drawn from certain nonpathogenic stocks. There exist diverse degrees of activity (1 to 7), corresponding to a strength of from 50 to 5,000 million organisms per cubic centimeter.

The preparation is administered by the intravenous method, at the rate of one injection every two or three days. One begins with one injection of 1 cc. of pyrifer of degree 1 activity. Then one increases the dose so that each time the temperature reaches from 39 to 40 C. For the first injections one increases the amount generally from the single to the double dose. When the larger doses, those of pyrifer of degree 4 activity and greater are reached, one progresses more slowly, giving about a third more of the amount previously injected. But all that is in theory. The progression should above all be made according to the reaction of the patient. Some patients have a high elevation of temperature after a weak dose. In these circumstances the rate of progression should be moderate. One important fact to know is that one must never make a fresh injection until the temperature has returned to normal. If for one reason or another it is necessary to interrupt the treatment for more than five days, one must begin again with a weaker dose than the last one given. One generally gives twelve injections. The treatment may be tried for elderly persons. One may give the treatment to persons who are going about, but there must be medical supervision.

Among the ophthalmologists who have made use of pyrifer may be mentioned G. V. Volkmann, Hessberg, J. Wolff, Kehrer, Kumbruck and Kramer.

Again attention must be drawn to cases in which it has been possible to check syphilitic atrophy of the optic nerve as there are cases in which the treatment has been without result. Kumbruck noted check of the atrophy in two of three cases.

Kramer applied the method for eleven patients suffering from parenchymatous keratitis. In seven cases the complaint remained unilateral. In four eyes the condition was cured, with vision of 1.

Kehrer abandoned pyrifur, from which he never had the slightest favorable result.

IV. SULFUR IN OIL

Let it be recalled first of all that sulfur in oil has been applied in the treatment of dementia paralytica for the last ten years. The first trials were made by Knud Schroeder, of Copenhagen, who observed cure in five of fourteen cases. His example was followed by others, who applied the method not only in cases of dementia paralytica but in many cases of syphilitic or nonsyphilitic disorders of the nervous system.

One generally employs a suspension of sulfur. Concentrations of 1:100 and 2:100 may be used. One commences by a trial dose of 1 cc. at a concentration of 1:100, which is increased if the temperature obtained is not sufficient, for it must reach about 40 C. The increase in dose is 1 cc. at a time. It is exceptional if it is necessary to increase it to more than 3 cc. One must be careful to heat the ampule first and to shake it well so as to obtain a perfect mixture. The injection should be strictly intramuscular, and it is recommended that it be given very slowly. The maximum temperature is obtained at the end of from eight to twelve hours. One generally notes a veritable febrile bell-shaped curve, the temperature reaching 40 or 40.5 C. The acme passed, the thermal reaction is followed immediately by a return to the normal temperature in twenty-four hours. As soon as the temperature has dropped, one makes a fresh injection, or one can wait two or several days. In that way one can make from one to three series of injections, consisting of from eight to ten injections each.

The product is well tolerated. Often there is more or less marked tenderness, with redness of the skin, around the center of the site of injection. Even severe pain radiating in the thigh has been remarked. In order to lessen these pains Renard and J. François inject, at the same time as the suspension of sulfur, an equal quantity of procaine hydrochloride in a concentration of 1:100 or 2:100. There are, moreover, a suspension of sulfur in oil to which anesthetics have been added and also a preparation containing anesthetics with a solution of sulfur in oil.

General accidents are exceptional. However, the patient sometimes suffers from nausea. P. Chauvillon has noted diarrheal stools and in one instance a purpuric exanthem of the legs. If the patient shows signs of fatigue during the treatment or gets thin, the therapy should be interrupted.

Ophthalmologists have had recourse to sulfopyretotherapy for a great number of complaints. They have used it not only for syphilitic

lesions but for many maladies which do not in any way come from syphilis.

L. Winkler, Weinberg, Roasenda, Tirelli, A. Ferrari, Livio-Pratti, Busacca, Kallmann, J. Fried and J. Smith have described the results which they have obtained in cases of syphilitic atrophy of the optic nerve. They all have reported success. Winkler ascertained notable improvement of the sight in three of five cases. Tirelli observed successful results in the same proportion of cases. Ferrari, as well as Livio-Pratti, mentioned good results. Busacca cited four cases in which central and peripheral vision had been improved. Kallmann mentioned two cases of atrophy of the optic nerve in which the condition was checked. Fried has seen remission in six of twelve cases, and Smith noted one case in which the status quo had been maintained. Also, Dreyfus gained the impression that the improvement is more marked in cases of tabes with an optic commencement.

The greater number of these authors combine chemotherapy with the sulfur treatment, principally having recourse to bismuth or mercury preparations, which they inject at the same time as the sulfur preparation or in the following days. L. Winkler utilizes an emulsion of bismuth subsalicylate in a concentration of 10:100 combined with oil containing sulfur. Roasenda makes an injection of mercury salicylarsenate the following day and an injection of a suspension of bismuth hydroxide in olive oil the day after that. Busacca also combines bismuth, and Livio-Pratti, bismuth and mercury. And they all deem that it is absolutely necessary that the intervention be energetic and early.

Several times hyperemia of the papilla has been noticed after the injections of sulfur in oil. This hyperemia is often accompanied by diminution of vision, which is only passing and which is followed by improvement. This papillary hyperemia has caused it to be said that the sulfur acts as a local stimulant of the nervous regeneration. L. Winkler, as well as Busacca, expressed the opinion that the sulfur has a specific chemical influence on the degeneration of the optic nerve.

Among the syphilitic conditions which are benefited by the sulfur therapy, one must mention parenchymatous keratitis. Knud Schroeder treated four patients with this condition. In all of them the result was particularly happy. L. W. Harrison, in two cases, obtained the same result.

Syphilitic choroiditis, as well as internal ophthalmoplegia, can also be favorably influenced by this treatment. Schroeder has seen the pupillary inertia reduced in a case of tabes. J. François related having observed after a few injections disappearance of the paralysis of accommodation and reestablishment of equal and normal pupils, which reacted to light, in accommodation and in convergence. Regular anti-syphilitic treatment had had no effect.

François has also told me of an observation, not published, of arachnoiditis of the optic chiasma, probably of syphilitic origin, for which a suspension of sulfur in oil proved of real utility:

A patient 29 years of age on Aug. 1, 1933, two years after the appearance of an ulcer, showed papillary stasis in the right eye and edema of the papilla in the left eye. Vision of the right eye was reduced to perception of movements of the hand, and that of the left eye was 1. Neurologic examination gave negative results. A roentgenogram of the cranium showed signs of old compression. Lumbar puncture was made. The spinal fluid pressure was 30 cm. with the patient sitting down. The spinal fluid contained 50 cg. of albumin per hundred cubic centimeters and 35 cells per cubic millimeter, 95 per cent of which were lymphocytes; the Bordet-Wassermann reaction was negative. Examination of the urine showed neither sugar nor albumin. The Bordet-Wassermann reaction of the blood was negative. Mercury cyanide was given subcutaneously. On August 6 vision was nil on the right and the same as previously on the left. On August 15 the condition was aggravated. On August 17 when decompressive trepanation was performed (by Dr. Demoor), the brain did not appear to be compressed. A right ventricular puncture was made. The intervention did not bring about any improvement. Injections of a bismuth preparation and of hypertonic dextrose solution were made. On September 5 papillary edema with beginning atrophy of the optic nerve was seen on the right, and papillary stasis was marked on the left. On September 14 another fresh intervention was undertaken. Exploration of the chiasmic region (by Drs. Martin and Demoor) showed the subarachnoid space partitioned with numerous adhesions to the dura mater and an accumulation of fluid. The optic nerves were double their normal size. The optic sheaths were incised for a length of 5 mm. The next day there was almost complete disappearance of the papillary stasis on each side. On October 27 vision of the right eye was nil; that of the left eye was ability to count fingers at 4 meters, and the visual field was practically complete. Injections of a bismuth and of a strychnine preparation were made. In November the left optic nerve showed progression toward atrophy, and vision was reduced to ability to count fingers at 2 meters. In December 1935 and in January 1936, ten injections of a suspension of sulfur in oil were made. After this treatment vision improved, that in the left eye becoming $1/3$ at the end of February. In April fresh treatment with a suspension of sulfur in oil was followed by further improvement. In February 1937 the right eye showed complete atrophy of the optic nerve, and the left eye had vision equal to $2/3$, feeble. On the left side there was a pale papilla of atrophied aspect; the field of vision was practically complete.

In regard to nonsyphilitic complaints for which injections of sulfur in oil are useful, A. Ferrari cited episcleritis, scleritis, iritis and corneal infiltrations. The result would be especially brilliant in cases of post-operative iridocyclitis. In glaucoma, sulfopyretotherapy is of no use.

V. HYPERTHERM OF KETTERING

The air-conditioned chamber called the Kettering hypertherm permits of obtaining a rapid increase of the patient's temperature and maintaining it as long as one wishes. In less than an hour one can increase the rectal temperature to 40.5 C. By means of currents of

cold air one can bring it back to normal in from thirty to forty minutes. This chamber is, in fact, a hot air cabin well regulated from the point of view of the temperature of the air, of the relative humidity and of currents of air. It is rectangular and has a length of 2 meters, a height of 75 cm. and a width of 90 cm. It is divided into two parts; one is the chamber destined for the patient and the other, which is smaller, contains the mechanism which is used for heating and humidifying the air and causing it to circulate. The ceiling is double. The anterior part of its interior layer is pierced with holes, through which the hot, humid air can penetrate into the compartment where the patient is. The flooring also is double. Its interior layer forms a rolling bed recovered by an air mattress that can be pushed into the interior of the cabin or drawn outside. The extremity of the bed is outside the chamber. It is a plank on which the head of the patient rests. At the side of this plank is a vertical panel that closes the chamber hermetically and that can be instantly raised, which permits the patient's being brought out in less than five seconds. The lower part of the panel has an opening to allow the neck to pass. This opening is closed with sponge rubber, which is covered with toweling to prevent the air from escaping. A pipe placed on each side of the plank allows for the running off of the excess sweat. The mechanism is comprised of an apparatus of three units for heating the air and two electric elements which heat a basin containing water. The hot, humid air is projected by a bellows between the two layers of the ceiling and passes from there through the holes into the interior layer and into the compartment where the patient is. The air circulates around the patient and then returns into the generating apparatus. On each side of the apparatus are sliding panels which permit verifying the rectal temperature, watching the blood pressure, noting the pulse rate and observing the skin.

A temperature of from 41 to 42 C. (106 to 108 F.) is necessary. The duration of the treatment varies from five to eight hours. It has been as long as ten hours. In saying five, eight or ten hours, one counts only the hours of fever. One must therefore add the time necessary for the rise of the temperature and for its return to normal, which represents about two additional hours. In short, one must count from seven to twelve hours for the seance. On an average, one gives five sessions at intervals of twenty-four hours. Sometimes one gives eight.

Generally the treatment is tolerated well if the patient is watched by a nurse used to the method. The nurse cannot leave for an instant. As the temperature increases, the patient perspires more and more. To avoid loss of weight and great weakness he has to drink during the session from 2 to 5 liters of an iced 0.6:100 solution of sodium chloride. If the taste is unpleasant, pure water is given alternately with the solution of sodium chloride. The patient must be fasting while given the

treatment. No nourishment is allowed as long as he is in the pyretogenic chamber; but as soon as the session is finished, he is given as much milk as he can take, and he is advised to take as much as possible during the following hours.

The complications of the treatment are of small importance. One meets with erythema, bullous eruptions of the skin and labial herpes. These lesions diminish as the sessions are repeated. Often there is cephalaea. One also meets with nausea and vomiting; they are especially noticed in patients who have not been fasting. Another complication—exceptional, it is true—is muscular tetany of the hands and the feet or even of the abdominal wall. This tetany can be made to disappear by means of the inhalation of nitrogen protoxide (a mixture of a 5:100 concentration of protoxide and a 95:100 concentration of oxygen) and by intravenous injection of calcium gluconate.

As contraindications one must mention advanced age, organic injury of the heart at all ages and cardiovascular alteration. The effects in cases of renal injuries are in general less harmful. Pulmonary tuberculosis is not a contraindication, but the respiratory insufficiency which results from it might prevent a sufficient increase of the temperature or the maintenance of a high temperature long enough to be efficacious (Desjardins, Stuhler and Popp).

The important work of Arthur M. Culler and Walter M. Simpson gives an idea of the value of the Kettering hypertherm in ocular therapeutics. In their report on artificial fever therapy in cases of ocular syphilis these authors related their observations on fifty-eight patients all having attacks of syphilitic complaints of the eyes.

As a technic they give ten sessions of hyperpyrexia at the rate of one per week, during which the patient is subjected for five hours to a temperature of from 40.5 to 41 C. They combine chemotherapy with hyperpyrexia, making thirty weekly injections of 0.2 Gm. of bismarsen (bismuth arsphenamine sulfonate), the first ten being given before the sessions of pyretotherapy are begun.

The fifty-eight patients who were thus treated were suffering from external ophthalmoplegia, parenchymatous keratitis, exudative uveitis, optic neuritis, neuroretinitis, choroiditis or atrophy of the optic nerve.

External Ophthalmoplegia.—Four cases were observed. Two of these were cases of recent involvement; in these improvement occurred.

Parenchymatous Keratitis.—Eleven patients were seen, ten of whom had received previous treatment. All these patients have attained vision greater than 1/5; eighteen have attained vision of 1/2 or more, and only one showed a recurrence during a period of thirty months, while previously during a period of two years he had had four recurrences. The opaque central disk of plastic exudate, which is the alarming sign of the malady, clears up well with this therapy.

Exudative Uveitis.—Ten cases were observed, in six of which the condition had occurred during the course of antisyphilitic treatment. In two cases it had been resistant to treatment with typhoid vaccine. Regularly, after the first or the second session diminution of the exudate, of the pain and of the photophobia was noticed and at the same time mydriasis was obtained.

Neuritis and Neuroretinitis.—Fourteen cases were observed, in two of which there were manifestations of secondary syphilis and in eight syphilis of the central nervous system. All the patients except two had been subjected previously to intensive treatment. After the hyperpyrexia treatment all had attained vision of $1/2$ or more, although in eight papillary paleness and slight contraction of the fields of vision remained.

Choroiditis.—Seven cases were observed. In all the condition had started, reappeared or progressed during antisyphilitic treatment. Treatment with the Kettering hypertherm brought about improvement in all.

Atrophy of the Optic Nerve.—Sixteen patients were seen. All except one had been treated previously. Vision and the fields of vision remained practically unchanged. The authors added: "If atrophy of the optic nerve is associated with foci of active infiltration along the optic tract, it is probable that such exudative lesions will respond to fever therapy."

Other Conditions.—Culler and Simpson brought about equalization of the pupils in three cases of the Argyll Robertson sign with anisocoria; in two of these cases there was some recuperation of the photomotor reflex.

Comment.—The results obtained by Culler and Simpson are interesting. It would seem that it is in cases of exudative uveitis that the treatment is particularly successful. That is also the opinion of William L. Benedict, who said that the best effects are obtained in ocular conditions accompanied by cellular infiltration, such as uveitis and keratitis. According to the same author, the duration of photophobia in interstitial keratitis is reduced by half and the corneal infiltration is less intense when one combines pyretotherapy with chemotherapy. The first attack responds better to the treatment than the successive ones.

VI. SHORT WAVES

I shall be fairly brief on the subject of short wave therapy, for the good reason that the observations on ocular diseases treated by short waves as producers of artificial fever are excessively rare.

The short waves are the hertzian waves nearest to the infra-red rays. They are between 50 and 10 meters in length.

There exist two main modalities of applying the short waves: (1) utilization of the vibratory action without an increase of the temperature and (2) local and general ultradiathermy.

It is evident that this therapy is only ultradiathermy generalized in pyretotherapy. It is electropyrexa. To this end the most useful waves are those of from 15 to 25 meters in length. Apparatus are required that generate current of high frequency which provokes the creation of an intense electric field, in which one places the patient. It

is no longer necessary to apply electrodes to the body of the patient. That is one of the great advantages of the method over diathermy, because there is no danger of burning. On the other hand, the heating is augmented in depth, while diminishing at the level of the tegument. The temperature increases rapidly. With apparatus for coupling by induction, as Leroy has indicated, one produces a temperature of 40 C. in a patient weighing 70 Kg. in half an hour. After this temperature is reached, it is maintained, owing to the slowing down of the apparatus, for four hours.

Electropyrexia demands rigorous supervision by a nurse-technician during the application and the repose which must follow. In general, there is no accident to be feared. Among the important contraindications may be mentioned cardiac decompensation, marked hypotension, tuberculosis in evolution and diabetes. The method also must not be applied to patients attacked by phlebitis, on account of the danger of embolism, or to those with varicose veins in whom a rupture might occur. It is also recommended that a patient should not be treated immediately after a meal, for fear of nausea and vomiting.

With regard to the results of electropyrexia in ocular conditions, A. Halphen and J. Auclair have reported that the atrophy of the optic nerve in persons with tabes is sometimes improved. Clear widening of the visual field has been remarked. Suzanne Schiff-Wertheimer reported the histories of two patients suffering from tabes with white papillae, who were subjected to short wave therapy and in whom the ocular condition remained unchanged. Injection of a bismuth preparation was made at the same time. The treatment was of five months' duration in one case and of six months' duration in the other. This author did not draw any conclusion from these trials, but insisted on the apparent innocuity of the treatment.

COMMENT

On the basis of my study of cases I can say that pyretotherapy makes for interesting successes in the field of ophthalmology. Among the diverse ocular complaints which derive benefit from artificial fever, one must place syphilitic lesions first. With pyretogenic treatment one can stabilize tabetic atrophy of the optic nerve in cases in which no treatment had previously succeeded in checking such lesion, the evolution of which is regularly progressive, as Morax said in the last edition of his history. Pyretotherapy does not, it is evident, give a perfect result, as it does not recover what is destroyed. But in the case of tabes one must be content with little and consider as a real success the stabilization of a lesion. And what about the modifications that one obtains in regard to the pupils? I shall simply recall that Dor said, in

his report on the treatment of ocular syphilis, that it is very difficult, in general, to cure pupillary troubles.

The efficaciousness of pyretotherapy being established in ophthalmology, one naturally asks oneself which pyretogenic agent should be given the preference and what the indications are.

In reality, all the methods are good, since happy results can be claimed for each. However, the greatest number of patients with atrophy of the optic nerve whom I have read of as having been favorably influenced had been subjected to malariotherapy. It is true that this is the oldest pyretogenic process. But let it not be forgotten that the authors have speculated as to whether the fever is the only factor in malarialization and whether there are not complex actions which accompany it.

The malaria cure has its inconveniences. First, there is the gravity of an inoculation with all its train of complications. Furthermore, it is a blind process which demands that the patient spend several weeks in an institution, which is certainly a disadvantage from an economic point of view.

For all these reasons, with equal chances of success, one must prefer a method less dangerous, more sure and easier to carry out.

Dmelcos therapy seems especially successful against acute and sub-acute infectious conditions, for which shock treatment has proved itself valuable for numerous years. But why does one want to substitute a pyretogenic agent for shock, which has never caused any grave troubles in the realm of ophthalmology and to which one owes so much success? Moreover, dmelcos therapy demands a great deal of prudence and often provokes great discomfort.

The same may be said of pyrifer, the use of which is less widespread.

And what is to be thought of sulfur in oil for which very interesting results can be claimed? It is still a product the use of which requires investigation. Notwithstanding, it would seem that injections at a really active concentration are very painful. Magitot stated that he has abandoned the use of sulfur in oil on account of the pain.

One arrives at a consideration of Kettering's hot air chamber and the short waves. They are the physical agents that realize pure hyperthermy and that have the great advantage of being able to start the fever and to proportion it at will. Certainly, they are agents which are still in their trial period. But if the results of Culler and Simpson are confirmed in the future, it is not impossible that the air-conditioned chamber will become the instrument chosen for treating ocular complaints by artificial fever, although it requires a great deal of good will on the part of the patient.

Concerning the indications for pyretotherapy in the field of ophthalmology, at the head of the list may be cited simple syphilitic atrophy of the optic nerve and pupillary troubles of syphilitic origin, for which no other treatment exists. One must also think of pyretogenic agents in cases of arachnoiditis of the optic chiasm of syphilitic origin; in cases of keratitis, in particular in those of parenchymatous keratitis of syphilitic origin, and in cases of inflammation of the uveal tract of no matter what origin.

CONCLUSIONS

I have reviewed a certain number of ocular maladies treated by hyperprexia. From these statements I shall draw a few practical conclusions.

I insist, first of all, on the utility of therapeutics by artificial fever in simple syphilitic atrophy of the optic nerve. Certainly, the results are neither constant nor perfect, but this is the only treatment which can check the lesion and so prevent the patient from becoming blind.

The pyretogenic processes also cause syphilitic pupillary troubles to disappear. Syphilitic parenchymatous keratitis, as well as keratitis, iritis, and iridocyclitis of all kinds, can be greatly benefited.

In cases of atrophy of the optic nerve it would seem that therapy with sulfur in oil and malarialization are the most efficacious forms of treatment. If one has recourse to malaria therapy, it is recommended that it be attenuated, the temperature not exceeding 40 C., and that quinine be given at the beginning of the inoculation.

Sulfur in oil seems to be indicated for pupillary troubles, and dmelcos for acute and subacute inflammatory conditions. In these cases of inflammation it would be sometimes useful to combine therapy shock with dmelcos.

As for treatment with the Kettering hypertherm and with the short waves, this is still in the experimental stage. One must, however, recognize that the results obtained with the Kettering hypertherm are particularly interesting, the more so as treatment with this apparatus is a physical method of pyretotherapy, in which everything therefore depends on the contribution of external calories, the amount of which one can easily regulate.

It is recommended that in cases of syphilitic complaints chemotherapy be combined with hyperpyrexia. Chemotherapy should be prolonged for quite a while.

One must also insist on the necessity of starting pyretotherapy as soon as possible, at the beginning of the complaint.

THE PROBLEM OF GLAUCOMA

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To the student of ophthalmologic history glaucoma presents a double problem. Did glaucoma prevail in ancient times, and, if it did, was it recognized as such by ancient physicians? There is no positive evidence in ophthalmologic literature to show that glaucoma was known earlier than a century ago. The clinical history, however, favors the belief that glaucoma is a disease of great antiquity. All known predisposing factors of glaucoma, such as old age, climatic conditions, hereditary and racial influences, nervous strain, inflammatory diseases of the eye, errors of refraction and other such possible causes, have always prevailed.

The identification of glaucoma in the early stages of the disease, however, appears to be of comparatively recent date. Ancients recognized it only in the final stage of the disorder as a special form of amaurosis which contributed to the widespread blindness prevailing in the ancient East.

GLAUCOMA AMONG THE ANCIENT HEBREWS

Both the Old Testament ¹ and the New Testament ² abound in cases of amaurosis, many of which were undoubtedly caused by hypertension of the eyeball. Four cases of blindness in the Old Testament are particularly suggestive of glaucoma, and I cite them here in chronological order:

1. "And it came to pass when Isaac was old that his eyes were dim so that he could not see." ³

2. "Now the eyes of Israel were dim for age so that he could not see." ⁴

3. "Now Eli was ninety and eight years old and his eyes were set; so that he could not see." ⁵

1. Genesis 27:1 and 40:10. Exodus 4:11. Leviticus 19:14 and 21:18. Deuteronomy 15:21, 27:18 and 28:29. I Samuel 4:15. II Samuel 5:6. I Kings 14:4. Isaiah 29:18 and 35:5. Zephaniah 1:17. Psalms 146:8. Job 29:15. Baruch 6:37.

2. Matthew 9:27-28, 11:5, 12:22, 15:30-31, 20:30 and 21:14. Mark 8:22 and 10:46. St. Luke 7:21-22, 14:13, 21 and 18:35. St. John 5:3, 9:1, 10:21 and 11:37. The Acts 13:11.

3. Genesis 27:1.

4. Genesis 48:10.

5. I Samuel 4:15.

4. "Now he [Ahijah] could not see; for his eyes were set by reason of old age."⁶

Before entering into a discussion of the clinical history in these cases, it should be pointed out that the word "dim" in cases 1 and 2 (meaning indistinct), as rendered in the revised version, is misleading. The Hebrew text has a different word for each case. In case 1, the term *zwattikhena* is used, which should be rendered "extinguished,"⁷ for according to the Biblical narrative Isaac suffered from total loss of sight. The patriarch could distinguish his two sons only by the sound of their voices and by his sense of touch. In case 2 the Hebrew text has the word *kabdu*, which does not mean dim. It is derived from the root *kabad*, meaning heavy⁸ or hard,⁹ and accordingly the text of case 2 should read "Now the eyes of Israel were heavy (or hard) from age so that he could not see." In each case the writer of Genesis gives as the cause of blindness old age, and in the case of Israel the writer emphasizes that the blindness of the patriarch was due to heaviness (or hardness) of the eyes, which he ascribed to old age.

More significant are cases 3 and 4. The Hebrew word *kamu* literally means "they stood still." The English version "eyes were set" practically expresses the same idea. In other words, the blind eyes of Eli and Ahijah were at a standstill. They could not fix on objects in front of them, as is characteristic in amaurosis following glaucoma, in which perception of light is gone; there is a peculiar stare and the eyes either do not move or do so aimlessly. This peculiar stare could not be mistaken for senile cataract, for in this condition there is usually some perception of light; the ocular muscles keep working in all directions to find a fixation point in order to locate luminous objects in front of the eye or to recognize dark objects in daylight.

The etiologic factors in all the cases cited bear a striking similarity; old age is given as the main cause of blindness. It is now generally agreed that the cause of glaucoma lies in those degenerative processes which are inseparable from the wear and tear of the living organism

6. I Kings 14:4.

7. (a) In Hebrew the term *Or* applies to sight, light and fire, as seen from Psalms 38:11: "The light (*or*) of my eyes is gone." The word *Kabah* (extinguished) applies also to blindness (Talmud Pesahim 62, folio b). "*Kabah meor emayim*" (extinguished is the light of the eyes) (Hag. 5: folio b). H. Gunkel in his commentary on Genesis (Genesis, ed. 2, Göttingen, 1902, p. 277; cited by Kotelmann, L. W.: [b] Die Ophthalmologie bei den alten Hebräern, Hamburg. L. Voss, 1910, p. 235, footnote 1569) renders the German version as follows: "Es begab sich, als Isaaq alt geworden und sein Augenlicht ganz erloschen war" (and it came to pass when Isaac was old and his eyes were extinguished).

8. Exodus 17:12. II Samuel 14:26. Psalms 38:4.

9. Exodus 8:11, 28:9 and 7:34.

occurring in old age.¹⁰ In all the aforementioned cases there is a history of mental and physical strain, which was recognized by ancient Hebrews as a predisposing factor of ocular trouble.¹¹ All these Biblical characters were living in the same environment and climate. Two pursued the life of shepherds, exposed to the hot sun during the day and to the cold and damp Palestinian air at night. The contrast between the glare of the sun by day and the cold damp night air is considered a factor in causing glaucoma.¹² (Maynard observed that more patients with glaucoma were under treatment during the rainy season in Calcutta hospitals than at any other time. He attributed this to the diminution of light which marks the cold and rainy season of India.)

All four of the affected persons just mentioned were members of the Semitic race, among whom glaucoma is especially prevalent.¹³ In cases 1 and 2 the characters showed a hereditary predisposition to glaucoma¹⁴; in cases 1, 3 and 4 the characters suffered total loss of vision; in case 2 sight was only partly impaired, and in all the cases the loss of vision was bilateral. If unilateral blindness, as well as amaurosis not contingent on old age, is barred, and senile cataract is eliminated for the aforementioned reasons, the clinical history in the four cases cited is strongly suggestive of glaucoma.

GLAUCOMA AMONG THE GREEKS

While the prevalence of glaucoma among ancient Hebrews is based more or less on conjecture, early Greek physicians appear to have iden-

10. Risley, S. D.: *An Injury Regarding Increased Tension of the Eyeball*, Ophthalmoscope 12:80, 1914.

11. The Psalmist complained, "Mine eye is consumed because of grief. It waxed thus because of all mine enemies" (Psalms 6:8). "Have mercy on me, O, Lord, for I am in trouble. Mine eye is consumed with grief; my strength faileth me; the light of mine eye is also gone from me" (Psalms 38:11). Seidel has observed two cases in which intense psychic excitement was followed at once by a glaucomatous reaction, in one instance for one day, and in the other for a week. He is of the opinion that emotion affects the vasomotor fibers, causing fluids in the uveal tract (*Psychic Factor in Intra-Ocular Fluid Exchange*, Arch. Ophth. 9:494 [March] 1933).

12. "Thus I was in the day, the drought consumed me and the frost by night" (Genesis 31:40). The continuous exclusion of light from the eye is known to produce mydriasis, thus predisposing to glaucoma.

13. Familial influence on the incidence of glaucoma is well recognized; the mode of action is ascribed to anatomic peculiarities and common environments. Laqueur stated that of the three ophthalmologists of his generation who suffered from glaucoma, Laval and he were Jews (Jackson, E.: *Ophthalmic Year-Book*, Chicago, Ophthalmic Publishing Company, 1910).

14. A. Brückner in a recent article has shown that glaucoma is hereditary in nature and that it attacks successive generations in the same decade of life. He believes it to be due to the influence of the vegetative nervous system and to climatic conditions (*Newer Knowledge of the Diagnosis and Therapy of Primary Glaucoma*, Schweiz. med. Wchnschr. 66:1264 [Dec. 12] 1936).

tified the disease in its late stage by a greenish discoloration of the pupil (green star).¹⁵ Hippocrates in his "Aphorisms"¹⁶ pointed out that among the well known diseases of the eye there is a disorder known as glaucoma, which is marked by a sea-colored pupil. "If the pupil [which he considered to be the center of sight] becomes sea-colored, sight is destroyed and amaurosis of the other eye often follows."¹⁷

Hippocratic writers stressed the color of the pupil as of great diagnostic value. Several colors of the pupil were recorded—light yellow, silver-gray, green or light blue, and deep blue. These colors were taken by the Greeks to identify various pathologic changes in the eye. The light yellow and silver-gray pupil referred to senile cataract (gray star).^{18a} The green or blue color was referred to by the Greeks as glaucoma.

Plato described the color of the pupil in glaucoma as "a cornflower blue mixed with white exhibiting a water blue color."^{18b}

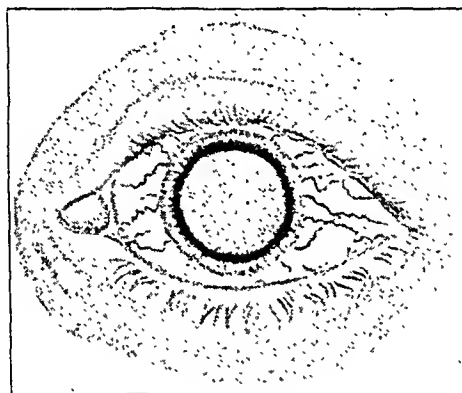


Fig. 1.—Photograph showing absolute glaucoma.

The gray star was recognized by Aristotle, who attributed the change of color in the pupil to the abstraction of fluid from the ocular organ. "In advanced age," he stated, "all parts of the body have a tendency to dryness."^{18c}

15. According to Julius Hierschberg, the term glaucoma signifies blue.

16. Hippocrates; Maximilien, P. E.: Lettre edition, Paris, 1839-1861, sect. 3, p. 31; sect. 4, p. 502.

17. Sea-blue refers to the color of the Mediterranean Sea. Being illuminated almost continually by a bright sunshine, it reflects the blue sky and appears light blue. Franz Delitzsch is of the opinion that among the Semites dimness of light was known as "blue." The "gray star" or "black star" was known as "blue star" (*Der Talmud und die Farben*. Nord und Süd, Leipzig, 1878, p. 261; cited by Kotelmann, L. W.: *Die Ophthalmologie bei den alten Hebräern*, Hamburg, L. Voss, 1910, p. 240, footnote 1602).

18. Cited by Kotelmann, L. W.: *Die Ophthalmologie bei den alten Hebräern*, Hamburg, L. Voss, 1910, (a) p. 239, footnote 1595; (b) p. 239, footnote 1600; (c) p. 237, footnote 1587.

Under the term amaurosis ancient writers lumped together all cases of blindness without reference to their etiologic factors. They considered blindness a disease and differentiated between the various forms of amaurosis by the color of the pupil. According to a manuscript ascribed to Galen, glaucomatous amaurosis is caused by pathologic changes in the humors of the eye which change the fluids to a blue color. The author probably was referring to postiritic glaucoma.

GLAUCOMA AMONG THE ROMANS

According to Ephesus Rufus (about 50 A.D.), a contemporary of Celsus, early Roman ophthalmologists considered glaucosis and hypochyma (cataract) identical terms. "Later writers," he stated, "distinguished between these two diseases. The first they applied to a watery crystalline lens that changed its color to blue; the second to a turbid fluid which settled between the iris and the lens (cataract). Both diseases terminated in amaurosis."

CONCEPTION OF GLAUCOMA AMONG BYZANTINE PHYSICIANS

In the centuries following the decay of the Roman Empire, throughout the Byzantine period down to the sixth century, no new thought in the field of ophthalmology was advanced. Medical writers depended entirely on the traditional works of Hippocrates, Galen and Celsus. Their authority was accepted without any question. Any change in the orthodox tradition was based not on evidence but on conclusions reached by comments and speculations on old texts. During these centuries, glaucoma was considered a form of cataract and was known as *cataracta complicata cum amaurosi*; the loss of vision was ascribed to desiccation of the lens brought about by conditions such as mydriasis, miosis, synchysis, and opacities in the aqueous.

There were, however, among the Byzantine ophthalmologists those who recognized the difference between amaurosis following hypochyma and that succeeding glaucosis. In the first instance the patient retained perception of light, while in the second this power was completely lacking. From a therapeutic point of view, they considered blindness following hypochyma amenable to treatment but that produced by glaucosis hopelessly incurable.

Alexander of Tralles (525 A.D.) in the section on ocular diseases in his medical work described the type of patients in whom glaucosis may be present: "Loss of vision and glaucosis is an affection of old people. Blue-eyed individuals are more prone to be affected than those who have dark eyes. Dilated pupils are more apt to be found in those who have large dark eyes."

One century later, Paulus Aeginta (625-690) followed the dictum of the Greeks and differentiated between amaurosis arising from glaucoma and that caused by other conditions. He asserted that the loss of vision in the former type is marked by blue discoloration of the pupil, but in the latter case the color of the pupil is not changed.

From the literature cited it is evident that the term glaucoma as understood by the ancients had no pathologic significance. The supposed bluish or greenish discoloration of the pupil is not typical even of the later stages of glaucoma, for such a green reflex of the pupil may be found among the aged, even in healthy eyes, as in cases in which the media are not completely transparent and particularly when the pupil is dilated by atropine.

MIGRAINE OF THE EYE AND HARDNESS OF THE EYEBALL

It was not until the middle of the fourteenth century that a certain form of ophthalmia was identified which approximated the modern description of glaucoma. Under the name "migrain of the eye" Samsal-din (1348), an Arab ophthalmologist, described an ocular disorder characterized in its acute stage by hemicrania, deep-seated inflammation of the eye and turbidity of the humors, followed occasionally by cataract and permanent dilatation of the pupil. He stated that if the disease became chronic it was associated with tenseness of the eyeball and impairment of vision. Though far in advance of the times, this account of absolute glaucoma failed to attract any attention, and for three centuries thereafter this disease was not identified directly or indirectly by ophthalmologic writers.¹⁹

RICHARD BANISTER'S DIAGNOSIS OF GUTTA SERENA

Three centuries later, Richard Banister (1626) in his "Breviary of the Eye" gave a description of a form of incurable cataract, gutta serena, which was analogous in its symptoms to absolute glaucoma. He pointed out the difference between gutta serena (incurable cataract), in which the blindness is associated with a transparent pupil, and gutta obscura (curable cataract), in which the blindness is associated with an opaque pupil. He suggested four different diagnostic signs by which the incurable cataract might be recognized: (1) hardness of the eyeball, (2) no perception of light, (3) long duration and (4) no dilatation of the pupil (if the sound eye was bandaged). He concluded that if these symptoms were present the cataract was hopelessly incurable.²⁰

19. Sorsby, Arnold: *A Short History of Ophthalmology*, London, John Bale, Sons & Danielsson, Ltd., 1933, p. 50.

20. Banister, Richard, cited by Sorsby, A.: *Hardness of the Eye: An Historical Note*, *Brit. J. Ophth.* 16:292 (May) 1932.

The observations of Banister, like those of his Arab predecessor, appear to have fallen on stony soil. The cardinal symptom of absolute glaucoma was lost sight of again for a period of one hundred and twenty-five years. It was rediscovered by the German anatomist Johann Zacharias Platner²¹ (1694-1747), of Leipzig, who, according to Terson, was the original discoverer. This view, however, because of the aforementioned evidence is hardly tenable. While Platner may not have been aware of Banister's discovery, he certainly cannot claim priority.

CONFUSION OF GLAUCOMA WITH CATARACT

Both Banister and Platner had no knowledge of the immediate cause of the hardness of the eyeball. They thought that it was a complicated form of cataract and that certain pathologic changes of the crystalline lens might in some way be responsible for the tenseness of the globe.



Fig. 2.—Portrait of Hermann Boerhaave.

This opinion was likewise held by many contemporaries, among whom might be mentioned the celebrated Herman Boerhaave (1668-1738), who under the name of *De Cataracta* described glaucoma as a malignant form of cataract that begins with acute pain and terminates in amaurosis.²²

21. Platner, J. Z.: *De motu ligamenti ciliaris in oculo*, Leipzig, ex. off. Langenhemiana, 1738; *Institutiones chirurgiæ rataionalis tum medicæ tum manualis in usum discentium*, Leipzig, The Author, 1745; cited by Sorsby, A.: *Brit. J. Ophth.* **16**:292 (May) 1932. This author contended that the ciliary body performs motor and secretory functions (cited by Snellen, H.: *A Historical Essay on the Development of Our Present Knowledge of Glaucoma*, *Ophth. Rev.* **10**:33, 1891).

22. Boerhaave, Hermann: *Prælectiones publicæ de morbus oculorum*, Paris, G. Cavalier, 1748, p. 107.

Beer²³ (1763-1821), of Vienna, thought that absolute glaucoma terminating in cataract and blindness was due to a form of malignant iritis distinguished from the benign type by greenish discoloration and dilatation of the pupil. He thought that, as in other forms of iritis, the underlying cause was a gouty and arthritic diathesis (hence the name "ophthalmia arthritica").

William Lawrence²⁴ (1783-1867), the English ophthalmologist, was of the same opinion. He thought that glaucoma was a chronic form of inflammatory iritis which affects the posterior coats of the eye. Among the symptoms he also stressed the greenish discoloration of the pupil. It is strange that neither Beer nor Lawrence mentioned hypertension as a cause.

Demours²⁵ (1762-1836) was the first to describe the symptom of "colors of the rainbow" (halo vision) around a light. This and increased tension of the eyeball he considered the essential symptoms of glaucoma. The associated pain he ascribed to oversensitiveness of the nervous system, and he attributed the disease to gout and rheumatism.

The etiology of this mysterious disease has always been the object of speculation. Galen thought it due to a pathologic alteration in the humors of the eye, which change from transparent crystal to dark blue, impairing the view of the visual spirit. Since then it has been variously regarded as a disease of the crystalline lens, a disease of the iris, an effusion between the retina and choroid, a manifestation of gout and rheumatism, an inflammation of the vitreous and a form of cataract.

BRISSEAU AND HIS DISCOVERY

The great interest manifested in the study of the eye by Rolfinck (1529-1673) and, a few years later, by Maître Jan (1650-1730), and particularly the anatomic and pathologic studies on enucleated eyes by Brisseau,²⁶ cleared the confusion between cataract and glaucoma (1709). Brisseau²⁷ is said to have dissected the eyes of Bourdelat, the physician of Louis XIV, who was blind from glaucoma and who willed his eyes for experimental research. His preconception led him to search first in Bourdelat's eyes for opacities in the crystalline lens. When, to his amazement, he found the crystalline lens transparent and in normal condition, he came to the conclusion that glaucoma is in no way related

23. Beer, Joseph: *Lehre von den Augenkrankheiten*, Vienna, C. F. Wappler, 1792. Beer was often called the "Father of Ophthalmology."

24. Lawrence, William, cited by Sorsby,¹⁹ p. 21.

25. Demours, Anthony P., cited by Wood, C. A.: (a) *American Encyclopedia and Dictionary of Ophthalmology*, Chicago, Cleveland Press, 1915, vol. 7, p. 5405.

26. Brisseau, Michael, cited by Gordon, B.: *The Problem of the Crystalline Lens*, *Arch. Ophth.* **14**:774 (Nov.) 1935.

27. Brisseau, Michael, cited by Cirincione, G.: *Appunti per il tratto di ottalmologia: Glaucoma*, *Ann. di ottal. e clin. ocul.* **58**:3 (Jan.); 99 (Feb.) 1930.

to cataract. But he committed a different error. While searching for the cause, Brisseau observed opacities in the vitreous of Bourdelat's eyes, and he took this unusual phenomenon to be the cause of his friend's blindness. Thus he took out, as it were, the disease from the lens and moved it back into the vitreous.

SCARPA AND HIS DESCRIPTION OF AMAUROSIS

During the latter half of the seventeenth century and the beginning of the eighteenth century, glaucoma was looked on as a form of amaurosis distinguished from other cases of blindness by definite signs.



Fig. 3.—Portrait of Antonio Scarpa.

Antonio Scarpa²⁸ (1752-1832), the famous Italian anatomist and ophthalmologist, in his "Treatise of Diseases of the Eye," under the caption "Amaurosis" described (1801) a form of amaurosis which is typical in its symptoms of the later stages of primary glaucoma. Among other things, he stated that the pupil "is so much dilated as to appear as if the iris were wanting, having also an unequal or fringelike margin; in which the bottom of the eye, independently of the opacity of the crystalline lens, has an unusual paleness, similar to horn, sometimes inclining

28. Scarpa, A.: A Treatise on the Principal Diseases of the Eye, translated from the Italian, with notes by James Briggs, London, T. Cadell and W. Davies, 1818, p. 455.

to green, reflected from the retina, as if from a mirror; which are accompanied with pain of the whole head, and with a constant or an intermitting sense of painful tension in the eyeball." In this description Scarpa pointed out the most essential symptoms of primary glaucoma which could be recognized without the aid of the ophthalmoscope, i. e., tension of the eyeball, headache, dilated pupils, cloudiness of the cornea and green discoloration of the pupil. It is surprising that in the literature on glaucoma no credit for pointing out the important symptoms was given to Scarpa.

Thirty years later (1831) Fabini,²⁹ professor of diseases of the eye at the University of Pest, stated that he frequently observed in his clinic patients whose eyeballs were "as hard as stone." He attributed the hardness to changes in the elasticity of the tunics of the eyeball. The prognosis of such cases he thought to be very grave.



Fig. 4.—Portrait of William Mackenzie. (From Wood, Casey A.: *American Encyclopedia and Dictionary of Ophthalmology*, Chicago, Cleveland Press, 1915, vol. 10, p. 7568.)

RECOGNITION OF PRIMARY GLAUCOMA BY HARDNESS OF THE EYEBALL

To William Mackenzie³⁰ is frequently credited the discovery of hardness of the eyeball in glaucoma. This, in view of the literature cited, is not tenable. Even his priority for the surgical device of paracentesis

29. Fabini, J. T.: *Doctrina de morbus oculorum*, Pesthini, O. Wigand, 1830, p. 23.

30. William Mackenzie considered glaucoma to be a form of cataract, the difference between senile cataract and glaucomatous cataract being that "In glaucomatous cataract the eyeball always feels firmer than normal while in senile cataract there is always the usual degree of resistance to finger pressure" (*Practical Treatise on the Diseases of the Eye*, London, Longman [and others], 1830). In the fourth edition of his work (1854) he stated that he ascribed the symptom to a troublesome choroid. In this edition he advocated paracentesis of the cornea as a prophylaxis and cure for glaucoma. The beneficial result, however, turned out to be of temporary success.

of the cornea for the relief of increased intra-ocular tension might be questioned, for Desmarres³¹ (1810-1882), of Paris, had resorted to the same operation for the same purpose some years before Mackenzie (1848).

In the United States, as late as 1837, glaucoma was still looked on by some writers as a form of amaurosis. Increased intra-ocular tension was not considered as the main symptom of the disease. Littell,³² a surgeon of the Wills Hospital of Philadelphia, gave the following definition: "Glaucoma is an affection resembling amaurosis in many of its symptoms, and principally characterized by a green, or yellowish discoloration of the vitreous humor, and impairment, or total loss of vision." He added, "It is attended with pain, slight in the commencement but progressively increasing, and a sense of fullness or tension in the globe, which is preternaturally hard to the touch." He adhered to the old notion that the discoloration of the pupil is the main diagnostic feature of glaucoma.

SCIENTIFIC APPROACH TO THE STUDY OF GLAUCOMA

While the discovery of hypertension of the globe facilitated the recognition of simple glaucoma early in the disease, in some cases the recognition of this condition by digital pressure could not be relied on unless the tension was high. It requires trained fingers and a delicate sense of touch to detect a high, a normal or even a medium amount of hardness. Moreover, increased intra-ocular tension, even when detected with a delicate tonometer, does not always signify glaucoma, nor does the absence of hypertension exclude glaucoma.³³ The diagnosis based on intra-ocular tension is rather of indirect value; the most important thing is to recognize the damage caused to the eye by the intra-ocular pressure. This was realized by the invention of Helmholtz (1821-1893).³⁴ His ophthalmoscope made possible the detection of glaucoma by observing an excavation in the disk and has enabled the surgeon to watch the pathologic changes in the papilla caused by the pressure within the eye.

31. Desmarres, L. A.: *Traité théorique et pratique des maladies des yeux*, ed. 2, Paris, Germer-Baillière, 1858, vol. 3, p. 737. Desmarres' secondary knife is still used by some European surgeons to split the cornea.

32. Littell, S., Jr.: *A Manual of the Diseases of the Eye*, ed. 1, Philadelphia, J. S. Littell, 1837, p. 183.

33. Arnold Knapp contended that the absence of hypertension does exclude glaucoma (*Association of Sclerosis of Cerebral Basal Vessels with Optic Atrophy and Cupping*, *Arch. Ophth.* 8:637 [Nov.] 1932).

34. Helmholtz, H.: *Beschreibung eines Augen-Spiegels zur Untersuchung der Netzhaut in lebenden Auge*, Berlin, A. Förstner, 1851.

Julius Jacobson, of Königsberg,³⁵ is credited with having first studied the interior of the eye with the ophthalmoscope in cases in which glaucoma was suspected. His paper on the subject (1853) is of historic interest, although his conclusions are rather of a negative character.

A year later (1854) Jaeger³⁶ (1784-1871), of Vienna, observed with the ophthalmoscope changes in the appearance of the papilla, which he erroneously described as "globular swelling."

VON GRAEFE AND HIS SCHOOL

Jaeger's illustrious student, von Graefe³⁷ (1828-1870), at first committed the same error. Both master and student seem to have been led to this error by the preconceived theory that the change in the disk is caused by exudates and dilated vessels in the optic papilla.



Fig. 5.—Portrait of Fred Jaeger. (From Wood, Casey A.: *American Encyclopedia and Dictionary of Ophthalmology*, Chicago, Cleveland Press, 1915, vol. 9, p. 6702.)

It should be remembered that prior to the invention of the ophthalmoscope only the secondary type of glaucoma was identified. The opinion prevailed that hardening of the eyeball is due to a congestive disturbance

35. Jacobson, Julius, cited by Garrison, F. H.: *An Introduction to the History of Medicine*, Philadelphia, W. B. Saunders Company, 1913, p. 552.

36. Jaeger, E.: *Ueber Staar und Staaroperationen*, Vienna, L. W. Seidel, 1854.

37. von Graefe, A.: (a) *Vorläufige Notiz über das Wesen des Glaucoma*, *Arch. f. Ophth.* **1**:371, 1854-1855; **2**:202, 1855-1856; (b) *Ueber die Iridectomy bei Glaucom und über den glaucomatösen Prozess*, *ibid.* **3**:456, 1857; (c) *Weitere klinische Bemerkungen über Glaucom, glaucomatöse Krankheiten und über die Heilwirkung der Iridectomy*, *ibid.* **4**:127, 1858; (d) *Weitere Zusätze über Glaucom und die Heilwirkung der Iridectomy*, *ibid.* **8**:242, 1862.

of the iris or the choroid. Both these conditions were thought to affect the clearness of the lens and vitreous, which resulted in blindness. The ophthalmoscope revealed that the eye may be glaucomatous without any pathologic changes in the uvea or in the outward appearance of the eye.

Weber,³⁸ a German physician, in 1856 was the first to demonstrate the cupping of the disk now recognized as the most important symptom of primary glaucoma. He also demonstrated by the direct method the different depths of the papilla in the various stages of glaucoma by the parallaxic movements which occur when the examiner changes the ophthalmoscope in different directions.

After this discovery, Heinrich Müller,³⁹ already famous for his investigation in the field of pathologic anatomy of the eye, observed excava-

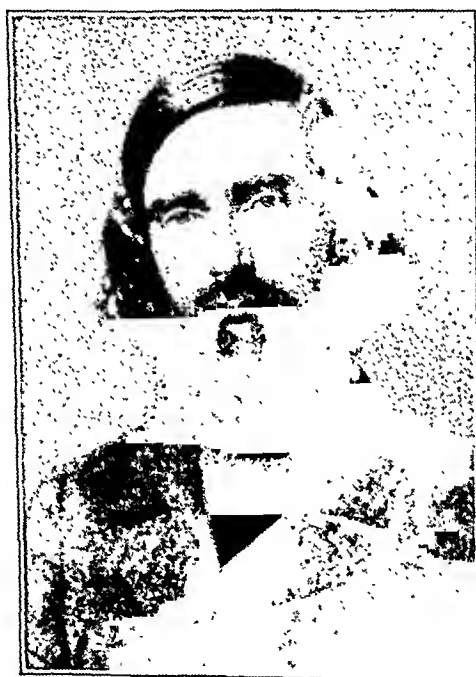


Fig. 6.—Portrait of Albrecht von Graefe.

tion of the papilla in enucleated eyes from glaucomatous patients. He ascribed the depression in the papilla to increased intra-ocular pressure.

With this knowledge, Donders⁴⁰ (1818-1889) proclaimed that glaucoma simplex is the basic form of glaucoma. He stated that the inflammatory symptoms which accompany it are only secondary.

38. Weber, A.: (a) Ein Fall von partieller Hyperämie der Chorioidea bei einem Kaninchen, *Arch. f. Ophth.* (pt. 1) 2:133, 1856; (b) Die Ursache des Glaucoms, *ibid.* 23:1, 1877.

39. Müller, Heinrich: Beschreibung einiger von Prof. v. Graefe extirpirter Augäpfel, *Arch. f. Ophth.* (pt. 1) 4:363, 1858.

40. Donders, Francis C.: (a) Die zichtbare verschijnselen van bloedsomloop in het oog, *Arch. f. Ophth.* (pt. 2) 1:75, 1854-1855; (b) On the Anomalies of Accommodation and Refraction of the Eye, translated by W. Daniel Moore, London, New Sydenham Society, 1864, p. 208.

VON GRAEFE AND IRIDECTOMY

An early diagnosis of glaucoma thus having been made possible by digital palpation of the eyeball⁴¹ and by ophthalmoscopic inspection of the fundus, the most perplexing problem which remained was how to check the progress of this dreadful disease. The first to offer a practical solution to this vexing problem was Albert von Graefe^{37a} (1856). While studying with the ophthalmoscope the changes in the fundus preceding the final stage of glaucoma, von Graefe became convinced that the increased pressure was not a mere complication but was the cause of all the symptoms of the disease. To relieve the pressure he applied his energy, his resourcefulness, his keen power of clinical observation and his masterly skill as a surgeon. His efforts were soon crowned with success. The discovery of iridectomy to combat glaucoma turned out to be one of the most important events in the history of ophthalmology of the nineteenth century.

This discovery of iridectomy did not come to von Graefe by mere chance. For many years before he had resorted to a similar surgical technic for the relief of staphyloma of the cornea. In the latter condition he noticed that the escape of the aqueous through the wound resulted in marked regression of the protrusion, and he tried the same technical procedure to alleviate the tension in glaucoma.

EARLY HISTORY OF IRIDECTOMY

The technic of iridectomy was not entirely new. William Cheselden (1618-1752) performed a somewhat similar operation for making an artificial pupil in cases in which the transparency of the pupil was impaired from congenital or inflammatory causes or from the couching operation for cataract. His technic, which consisted of introducing a needle through the sclera, was, however, not well adapted for the intended purposes. It was of only temporary value, as the opening soon became closed by adhesions, and it frequently caused damage to the ciliary body. This operation was modified eleven years later by Samuel Sharp (1774-1778). His method was transfixing by one incision the cornea and the iris across the anterior chamber. Sharp's technic fared no better than that of Cheselden. It made no impression on his contemporaries. Sixty-one years later (1801) the operation was revived by Anthony P. Demours (1762-1836), who claimed it as his own. Other modifications of this operation followed, among which should be men-

41. William Bowman (On Glaucomatous Affectations, and Their Treatment by Iridectomy, *Brit. M. J.* 2:377, 1862) ascertained by digital touch the different degrees of tension. Starting from normal, three degrees may be elicited in each direction—plus 1, 2 and 3 and minus 1, 2 and 3.

tioned the division of the sphincter muscle at the pupillary margin (iridotomy), but this also fell into disrepute. It was finally resurrected by Joseph Beer (1763-1821), who devised a knife (1798) for the operation. Beer performed iridectomy in cases of impaired vision due to leukoma, corneal adhesions or staphyloma, as a means of forming an artificial pupil.⁴²

Shastid⁴³ has expressed the opinion that credit for priority in regard to the iridectomy operation as performed for the treatment of glaucoma belongs not to von Graefe but to Beer. Be this as it may, ophthalmologists are indebted to von Graefe for introducing this device for the prevention of blindness in simple glaucoma at a time (1857) when even temporary relief from miotics was not known (miotics were discovered in 1875).

In reading the ophthalmologic literature of that period one is greatly amazed by the bitter controversy evoked by the discovery of iridectomy. The participants did not always refrain from personal abuse. Some surgeons looked on the operation as a harmful experiment; others objected to iridectomy because the rationale for the operation was rather vague. It must be remembered that von Graefe first ascribed the lowering of the tension after the operation to the escape of the aqueous through the opening of the incision. But, observing that the anterior chamber refills within twenty-four hours after the operation, he advanced the theory that the ocular fluid is secreted partly or wholly by the iris, and that by cutting a part of the iris the secretion becomes permanently lessened. Neither of these theories was satisfying.

DE WECKER AND HIS IDEA OF CONTINUOUS FILTRATION

It was due to the persistent efforts of his disciple Louis de Wecker (1836-1906) that the unreasonable opposition to von Graefe's skilful surgical methods subsided, and the curative value of iridectomy was established.⁴⁴

De Wecker differed, however, from his master in the rationale for the decrease of tension after the operation. He advanced the opinion that the success of iridectomy depends on the continuous filtration of the ocular fluid through the cicatrix.⁴⁵

Convinced of the soundness of his theory, he concluded that the beneficial results of the operation could be made more permanent if a fistula could be provided whereby the retained fluid could drain freely

42. Beer, Joseph, cited by Sorsby,¹⁹ p. 57.

43. Shastid, T. H., in Wood, C. A.: *American Encyclopedia and Dictionary of Ophthalmology*, Chicago, Cleveland Press, 1915, vol. 7, p. 5623.

44. de Wecker, L.: (a) cited by von Graefe^{37a}; (b) *Valeur de l'iridectomie dans le glaucome*, Bull. et mém. Soc. franç. d'ophth. **18**:1, 1901.

45. de Wecker, L.: (a) *Ocular Therapeutics*, translated and edited by Litton Forbes, Smith Elder & Co., 1879, p. 259; (b) p. 249; (c) pp. 249-259.

from the interior of the eye into the subconjunctival sac.^{45b} This conclusion led to his device of sclerotomy and proved to be the basis of most surgical methods now in use for the treatment of glaucoma. De Wecker defined glaucoma as a disturbance of the equilibrium between secretion and excretion with an increase of the contents and tension of the eye, the severity of the attack depending on the degree and rapidity with which the balance is offset. He offered no solution as to the nature of the disturbance that offsets the balance of the ocular fluid.^{44b}

Von Graefe deserves admiration also for presenting a graphic description of primary glaucoma which has since been accepted as classic by authors of textbooks. The symptoms, as pointed out by von Graefe, in addition to increased tension and excavation of the papilla, are acute supra-orbital pain, dilatation of the pupil, shallowness of the anterior chamber, cloudiness of the media, loss of corneal sensibility, rapid impairment of vision and a contracted field, all of which he attributed to the increased intra-ocular tension, particularly in cases in which such tension rises rapidly.^{37b} Von Graefe was also first to point out the danger of administering atropine in the treatment of glaucoma, a practice which was then common.^{37c}

Holth⁴⁶ has shown that von Graefe was the first to observe transitory leveling of the glaucomatous cup after the successful performance of iridectomy. "In this way I saw deep cavities change within a week into flat basin-like depressions," he stated.

After this disclosure of von Graefe, Lange⁴⁷ observed diminution in the depth of the glaucomatous cup after the use of miotics.

DISCOVERY OF ARTERIAL PULSATION

The effect of the pressure on the ocular circulation was the next step in the study of the fundus in glaucoma. The first to investigate this subject was Donders (1855-1856), who observed that digital pressure on the eyeball produces a venous and arterial pulse resulting in momentary blurring of vision. This important discovery led to the detection (1859) of arterial pulsation in glaucoma by von Graefe. The study of vascular pulsation was continued by Coccius (1872), who demonstrated that the harder the eye, the more marked is the arterial pulse, and that the pulsation of the central artery is the true index in the study of the various stages of glaucoma.⁴⁸

46. Holth, S.: On My Technique in Limbal Sclerectomy for Glaucoma, *Ophthalmoscope* 9:87, 1911; 12:347, 1914.

47. Lange, O.: Zur Lehre vom Glaukom, *Klin. Monatsbl. f. Augenh.* 2:540. 1912.

48. Coccius: *Arch. f. Ophth.* 11:373, 1872.

RATIONALE OF IRIDECTOMY

While the discovery of iridectomy has in a measure solved the problem of combating intra-ocular hypertension, the rationale of the operation still remains an open question. Von Graefe, who first ascribed the lowering of the tension after the operation to the loss of the aqueous through the opening of the incision, believed that the quantity of fluid in the eye does not change materially during life and, once lost, does not return to pathologic proportions.⁴⁹

Leber and Coccius⁴⁹ also attributed the decrease of the tension after the operation to the loss of membrane of the iris, not because it lowers the amount of secretion but because it opens a free communication for the passage of fluid between the anterior and posterior chambers.

Bowman assumed that the exposing of the zonula by the operation facilitates the passage of fluid from the vitreous to the anterior chamber, whence it is absorbed by osmosis.⁵⁰

De Wecker^{45c} contended that the success of iridectomy is dependent on the continuous filtration of the ocular fluid through the cicatrix.

Ulrich,⁵¹ who expressed the belief that a water-proof iris is the cause of hypertension, theorized that the perforation of the iris removes the impenetrable condition of the iris and permits free communication of fluid between the chambers.

Nuel explained the effectiveness of iridectomy by the hypothesis that the ocular fluid is secreted by the iris. Thus when a part of the iris is cut away, less fluid will enter the eye.

Henderson suggested that iridectomy opens new avenues for excretion of the intra-ocular fluid through the edges of the coloboma, which, in his opinion, are never cicatrized.

Czermak⁵² theorized that the cutting of the pectinate ligament forms a direct communication between the anterior and posterior chambers.^{38b}

Weber^{38b} asserted that the operation detaches the adhesions of the iris from the angle of the anterior chamber and reestablishes the normal outflow. This theory, which gained universal acceptance for a time, has lost ground of late. The studies of Troncoso and others have shown that the reopening of the angle is not a necessary condition for the success of iridectomy. These authors proved that the contents of the eye drain perfectly after iridectomy, even when the peripheral synechia is

49. Coccius, E. A.: *Ueber Glaucom, Entzündung und die Autopsie mit dem Augenspiegel*, Leipzig, I. Müller, 1859.

50. Bowman, W.: *A Discussion on the Value of Iridectomy in Glaucoma*, Tr. Internat. Cong. Ophth., 1872, p. 194.

51. Ulrich, R.: *Studien über die Pathogenese des Glaucoms*, Arch. f. Ophth. 30:235, 1884.

52. Czermak, Wilhelm: *Die augenärztlichen Operationen*, Vienna, C. Geraldts & Sohn, 1898, p. 181.

not detached. Troncoso attributed the beneficial results of iridectomy to drainage of the fluid through the edges of the coloboma, to the provision of intercommunication between the chambers and, in some cases, to the opening of the outlet that was blocked by the synechia.⁵³

There are many other theories that offer an explanation for the curative effect of iridectomy in glaucoma, but so far no satisfactory elucidation has been given. The difficulty lies in the fact that, notwithstanding the extensive laboratory and clinical investigations, the pathogenesis of primary glaucoma is still *terra incognita*, and without a knowledge of the etiology, the treatment must necessarily remain symptomatic and empirical.



Fig. 7.—Portrait of Sir William Bowman.

SOURCE OF THE INTRA-OCULAR FLUID IN THE NORMAL EYE

When the problem of the intra-ocular tension in primary glaucoma was first approached, two theories were presented as to the source of the intra-ocular fluid in the normal eye. One was the stagnation theory, which maintained that the aqueous is formed at birth and unless influenced by disease remains unchanged throughout life. The other, known as the circulation theory, is that of Leber and his collaborators, which proposed that the aqueous keeps changing in the eye continuously.

The first theory, which received the support of early writers, has lost its prestige in recent years. The second theory, which is generally

53. Troncoso, M. U.: Closure of the Angle of the Anterior Chamber in Glaucoma, *Arch. Ophth.* **14**:557 (Oct.) 1935.

accepted, has received various explanations as to the mode of action. Leber thought that the aqueous is formed from the blood after having been filtered through the walls of the capillaries by the pressure of the blood. Seidel postulated that the aqueous is secreted by the glandlike epithelium of the ciliary body.⁵⁴ Friedenwald and Pierce contended that the aqueous is formed mainly by the ciliary processes by the mechanism of ultrafixation. The outflow through Schlemm's canal takes place under the influence of osmotic forces due to the pressure of the blood plasma in Schlemm's canal. The outflow mechanism of Schlemm's canal can take care of ten times the normal circulation, with a rise in the intra-ocular pressure of only a few millimeters of mercury.⁵⁵ Other investigators have stated the opinion that the secretion is formed by the blood but that before it reaches the anterior chamber it is filtered through the ciliary processes.

The theory which has gained ground recently is that of dialysis. It presumes the existence, in the walls of the capillaries, of a semi-permeable membrane which permits water and dissolved solids to pass through but blocks the passage of undissolved colloidal substances, rich fluids and proteins.

It is manifest from the brief review just given that the source, as well as the character, of the contents of the intra-ocular fluid in the normal eye is still a matter of speculation.

THEORIES OF INTRA-OCULAR HYPERTENSION

To the earlier pathologists who believed that all forms of glaucoma were secondary to ocular disorders such as diseases of the choroid, lens, iris and blood vessels, the etiology of glaucoma did not present any problem. It was ascribed to the antecedent disease, but since the ophthalmoscope revealed a primary form of the disease a knowledge of the cause is pertinent.

The theories advanced within the last seventy-five years to explain the cause of ocular hypertension would make up a volume by itself and would be entirely beyond the scope of this paper. A brief review of the leading theories, however, merits consideration.

Theoretically, the tenseness of the eyeball in primary glaucoma could arise from one of the following four causes: (1) hypersecretion, (2) retention of fluid within the globe, (3) anatomic changes within the eye and (4) changes in the composition of the intra-ocular fluids.

54. Seidel, E., cited by Adler, F. H.: Is the Aqueous Humor a Dialysate? *Arch. Ophth.* **10**:11 (July) 1933.

55. Friedenwald, J. S., and Pierce, H. F.: Circulation of the Aqueous, *Arch. Ophth.* **8**:9 (July) 1932; **10**:449 (Oct.) 1933.

Von Graefe first assumed that the increased volume of the eyeball is due to hypersecretion of fluid from the iris and choroidal vessels as a result of the inflammation of that structure. The invention of the ophthalmoscope prompted him to change his view. That instrument, which made possible the recognition of primary glaucoma, did not show any pathologic changes in the choroid or the iris. He consequently postulated the theory of serous choroiditis, the existence of a disorder of the choroid in which the eye did not show any pathologic changes.⁵⁶ This view gained the support of many contemporaries, among whom might be mentioned his disciple, de Wecker.^{45b}

Donders, who was first to maintain that glaucoma simplex is the typical form of the disease, also stated the belief that the oversecretion of the choroid is the basis of hypertension. The secretion, however, he thought is affected by nervous irritation of the choroid similar to that present in glands when certain nerves are stimulated. Hence he termed the process "neurosis secretion."⁵⁷

Bowman⁵⁸ assumed that the hardness of the eyeball is due to the anatomic disproportion between the size of the eye and that of the crystalline lens, i. e., the existence of a congenital small eye with a normal lens or that of a normal eye with a large lens. "The decisive fact in determining the onset of glaucoma is the size of the eye in relation to the lens."

Priestly Smith⁵⁹ held that smallness of the cornea predisposes to glaucoma by the diminution of the perilenticular space through the resulting change of position of the ciliary body. He found that the cornea is, as a rule, smaller in glaucomatous eyes (measuring, on an average, 11 mm. horizontally and 10.3 mm. vertically, against 11.6 and 11 mm., respectively, in the normal eye). The predisposition to glaucoma is particularly marked in advanced age with the tendency toward abnormal growth of the lens. "It is well known," this author stated, "that glaucoma is more frequent in the short eye, and if to this is added an abnormally large lens, an increase in tension would be the natural consequence."

The relation between the internal capacity and the elasticity of the envelope of the eyeball, on the one hand, and the amount of its contents,

56. von Graefe, cited by Fuchs,⁶⁰ p. 416.

57. Donders, cited by Fuchs,⁶⁰ p. 416.

58. Bowman, William: *On Glaucomatous Affectations, and Their Treatment by Iridectomy*, Brit. M. J. **2**:377, 1862.

59. Smith, Priestly: *On the Shallow Anterior Chamber of Primary Glaucoma*, Ophth. Rev. **6**:191, 1887; Tr. Internat. M. Cong., 1894, p. 33; *Glaucoma: Pathogenesis, Symptoms, Causes and Treatment*, in Norris, W. F., and Oliver, C. A.: *System of Diseases of the Eye*, Philadelphia, J. B. Lippincott Company, 1898, pp. 650-651.

on the other, has been suggested by Fuchs.⁶⁰ If the latter increases or the former diminishes, the pressure is elevated.

Stellwag von Carion⁶¹ maintained that the rise of pressure is due to the increased blood pressure in the vessels of the interior of the eye in consequence of obstruction of their return circulation—venous stasis. The extended vessels fill a part of the cavity and press the fluid forward.

Salzmann⁶² noticed that in glaucoma the lumen of the central vein is progressively narrowed down to complete occlusion.

Bartels⁶³ found narrowing of the interscleral section of the anterior ciliary arteries and expansion of the posterior ciliary arteries in glaucoma. He expressed the belief that in glaucoma the ocular blood vessels are frequently diseased. He questioned, however, if this is the original cause of the condition, because such changes in the blood vessels are also observed in arteriosclerosis.

Verhoeff⁶⁴ in ten cases of primary or secondary glaucoma found sclerosis of the ligamentum pectinatum, i. e., a general thickening of the network of the ligament, with new-formed tissue on its surface, dependent on a preceding anterior synechia which had been separated at the periphery.

Henderson⁶⁵ contended that the closure of the angle in primary glaucoma is caused by sclerosis of the sclerocorneal trabeculum. He noticed in occasional cases atrophy of the ligament epithelium at the iris and in some instances exfoliation of the lens and capsule.

Roemer⁶⁶ in a case of simple glaucoma observed sclerosis of the trabeculae and of the spaces of Fontana, with deposits of pigment.

VASCULAR CHANGES AS THE CAUSE OF GLAUCOMA

With the new conception of the permeability of the capillaries, the importance of vascular changes as a source of hypersecretion of fluids and colloids in the eyes has of late been brought to the fore.

60. Fuchs, E.: *Text Book of Ophthalmology*, ed. 3, translated by Alexander Duane, Philadelphia, J. B. Lippincott Company, 1908, pp. 413-417.

61. Stellwag von Carion: *Arch. f. Ophth.* (pt. 2) **2**:202, 1874; cited by Fuchs,⁶⁰ p. 416.

62. Salzmann, M.: *Die Ophthalmoskopie der Kammerbucht*, *Ztschr. f. Augenh.* **31**:1, 1914; **34**:26, 1915.

63. Bartels, cited by Wood, C. A.: *Eye, Ear, Nose and Throat*, Practical Medicine Series, Chicago, Year Book Publishers, Inc., 1918, p. 103.

64. Verhoeff, F. H.: *Histological Findings After Successful Sclerostomy*, *Arch. Ophth.* **44**:129, 1915.

65. Henderson, F.: *Glaucoma: An Inquiry into the Physiology and Pathology of Intra-Ocular Pressure*, London, E. Arnold, 1910.

66. Roemer, cited by Elliot, R. H.: *A Treatise on Glaucoma*, London, Hodder & Stoughton, 1922, pp. 40, 51 and 71.

Starling demonstrated that lymph is formed in the tissues of the body by the process of filtration through the walls of the capillaries. According to Leber,⁶⁷ lymph infiltrated from the capillaries also forms the main source of ocular secretion. More recent observations in the study of physiology revealed that the lymph is a simple dialysate from the blood plasma. Duke-Elder has shown experimentally that the theory of dialysis holds true with regard to the ocular fluid. The difference in pressure which exists in the various tissues of the body is generally accepted to be influenced by the difference in the permeability of the capillary walls, which are the dialyzing membranes. The original energy influencing the pressure in the tissues of the body is derived from the general blood pressure affected by the action of the heart. Manometric observation indicated that changes in the intra-ocular pressure follow changes in the blood pressure. Duke-Elder estimated that the average pressure in the intra-ocular arteries is 88 mm. of mercury systolic and 64 mm. diastolic. The pressure of the internal carotid artery that supplies blood to the eye is a little less than that of the brachial artery, which is from 110 to 125 mm. systolic and from 60 to 80 mm. diastolic. The arteries of the eye which are under control of the vasoconstrictor fibers derived from the cervical portion of the sympathetic system are subject to variations in caliber, pressure and permeability and are of great importance in the study of glaucoma.

CHANGES IN THE TERMINAL VESSELS AS A CAUSE OF GLAUCOMA

As early as 1884 Birnbacher⁶⁸ attributed the hypertension to the damage done to the terminal vessels by the retardation of the venous circulation. He observed in glaucomatous eyes considerable cellular infiltration in and around the vessels and the lymph spaces. He also noted proliferation of the endothelium of the veins and congestion and swelling of the neighboring structure of the vessels.

Duke-Elder⁶⁹ observed dilatation and an increase of permeability of the minute vessels of the surface of the iris in glaucoma. He found that the protein of the aqueous which had escaped from the permeable vessels was at times sufficient to form a clot and block the canals. The same author intimated that the glaucomatous crisis might be produced

67. Leber, cited by Parsons, J. H.: *Diseases of the Eye*, ed. 8, New York, The Macmillan Company, 1936, p. 15.

68. Birnbacher, cited by Elliot, Robert Henry: *Glaucoma*, New York, Paul B. Hoeber, 1918, p. 101; cited by von Graefe, A.: *Wundbehandlung bei Augen-Operationen mit besonderer Berücksichtigung der Staare-Extraction; Operation unreifer Staare*, *Arch. f. Ophth.* (pt. 4) **30**:211, 1884.

69. Duke-Elder, S.: *The Aetiology of Glaucoma*, *Tr. Ophth. Soc. U. Kingdom* **53**:281, 1933. Duke-Elder, S., and Duke-Elder, P. M.: *Etiology of Glaucoma*, *Arch. Ophth.* **11**:49 (Jan.) 1934.

by the liberation of histamine-like bodies in the eye, caused by the destructive rise of pressure. He induced a vascular crisis in the eye of animals such as might result clinically in acute glaucoma by raising the intra-ocular pressure mechanically to a height above that of the ophthalmic artery.

Mészáros and Toth⁷⁰ found distinct changes in the structure and functions of the vessels and capillaries of glaucomatous patients. Primary glaucoma, in his opinion, is associated with pathologic changes of the vascular system.

Schmidt⁷¹ in an analysis of thirty-four patients with glaucoma simplex found that thirty-three showed a disturbance of the capillary system throughout the body. The rise of pressure which occurred during the course of his experiments on glaucomatous eyes was accompanied by a local disorder of the capillaries on the same side. His conclusion agrees with the results of the studies of Friedenwald,⁷² who found that acute glaucoma is regularly associated with vascular lesions localized in the capillaries.

Wegner⁷³ observed in 70 per cent of patients with chronic simple glaucoma a definite disturbance of the capillary endothelium throughout the body. He concluded that glaucoma is a general disease and not merely a local disturbance.

De Saint-Martin and Mériel⁷⁴ studied twenty-two consecutive patients with glaucoma with the oscillometer of Boultite. All manifested a widespread vascular disorder. Similar observations were made by Ferrari⁷⁵ and Troncoso.⁷⁶ The last suggested as a working hypothesis the assumption that simple glaucoma is a chronic vascular disease. He was of the opinion that only in the event of a permanent increase of capillary permeability accompanied by severe nervous and congestive

70. Mészáros, K., and Toth, Z.: Ueber das periphere Gefäß-system von Glaukomkranken, *Klin. Monatsbl. f. Augenh.* **90**:67 (Jan.) 1933.

71. Schmidt, K.: Klinische und experimentelle Studien über lokale und allgemeine Gefäß-störungen beim Glaucoma simplex, *Arch. f. Augenh.* **100-101**:190, 1929.

72. Friedenwald, Jonas S.: The Pathogenesis of Acute Glaucoma, *Arch. Ophth.* **3**:360 (May) 1930.

73. Wegner, Wilhelm: Ueber die Bedeutung des Flüssigkeitsaustausches zwischen Blut und Gewebe für das Glaukom, *Arch. f. Augenh.* **103**:511 (Dec.) 1930.

74. de Saint-Martin and Mériel, P.: Glaucone et tension moyenne, *Arch. d'opht.* **49**:705 (Nov.) 1932.

75. Ferrari, A.: Glaucoma primario e resistenza globulare media contributo alla conoscenza della morfofisiologia del sangue nel glaucoma, *Arch. di ottal.* **39**:147 (April) 1932.

76. Troncoso, M. U.: Patogenesis del glaucoma investigaciones clínicas y experimentales, *An. de oftal.* **4**:97, 135 and 167, 1901-1902.

symptoms does the pressure become permanently high. "Under such conditions," he added, "the colloids within the aqueous increase the tension by permanently closing the angle of the anterior chamber." Excavation of the disk and atrophy of the optic nerve take place, according to Troncoso, only when there is malnutrition of the retina and optic nerve.

Sondermann,⁷⁷ after an extensive study of the subject, suggested that four elements might be responsible for the pathogenesis of primary glaucoma: (1) the blood pressure in the capillaries of the uvea, (2) the osmotic blood pressure, (3) the amount of fluid entering the eye and (4) the degree of elimination of fluid from within the eye. "In advanced life," he maintained, "because of the increase of sclerosis of the sclera and the resultant increase of pressure in the vortex veins, there is an increase in the aqueous production as well as in its outflow." Glaucoma, according to Sondermann, depends on the rapidity of the sclerosing process in the sclera and the trabecula.

Tewbin and Wilensky⁷⁸ in the ophthalmic clinic of Moscow State University and the clinic of the Kasan State Institute observed during a period of ten years changes in the vascular system and in the capillary network in juvenile glaucoma.

RELATION OF GENERAL BLOOD PRESSURE AND INTRAOCULAR PRESSURE

The important part played by the systemic blood pressure on the intra-ocular hypertension has been stressed of late by many observers. Uyemura and Suganuma⁷⁹ with their newly devised instrument, the ophthalmodynamometer, determined that there is a decided relationship between the general blood pressure, the pressure in the retinal vessels and the intra-ocular pressure.

A similar conclusion was reached by Parson and by Jackson, Adler and Landis.⁸⁰ Their researches have shown that an increase in the general blood pressure produces a corresponding increase in the intra-

77. Sondermann, S.: *Meine Glaukomtheorie und die Klinik des Glaukoms*, *Klin. Monatsbl. f. Augenh.* **92**:313 (March) 1934.

78. Tewbin, B. G., and Wilensky, L. I.: *Zur frage der Gefässdestruktion beim Glaukom des Jugendalters*, *Ztschr. f. Augenh.* **80**:141 (April) 1933.

79. Uyemura, M., and Suganuma, S.: *Ueber einen neuen Ophthalmodynamometer*, *Klin. Monatsbl. f. Augenh.* **96**:481 (April) 1936. Suganuma, S.: *Studien über den Blutdruck in der Zentralarterie der Netzhaut; über den Blutdruck in der Zentralarterie der Netzhaut bei gesunden Menschen und über seine Beziehung zum allgemeinen Blutdruck*, *ibid.* **96**:74 (Jan.) 1936.

80. Jackson, C. L.; Adler, F. H., and Landis, E. M.: *Tonic Effect of Sympathetic on Ocular Blood Vessels*, *Arch. Ophth.* **53**:239 (May) 1924.

ocular pressure. A sudden harmful increase is prevented by the local vasoconstrictor fibers through the cervical portion of the sympathetic nervous system. Vele⁸¹ maintained that the systolic and diastolic blood pressures are higher in glaucomatous patients than in normal persons.

On the other hand, the investigation of Seidel did not reveal any marked relation between the general blood pressure and the intra-ocular pressure.

Hertel⁸² showed that an increase in the systemic blood pressure affects the eye only when it comes on suddenly. Otherwise its action is not necessarily marked.

Similar conclusions were reached by Weinstein,⁸³ whose observation of three hundred selected glaucomatous patients indicated that while there was some rise in the general blood pressure, the increase was not of such an extent as to be considered pathognomonic of glaucoma.

Block and Oppenheimer⁸⁴ found no apparent relationship between the intracranial pressure and the intra-ocular tension.

SYMPATHETIC NERVOUS SYSTEM, A REGULATOR OF OCULAR TENSION

Far back in 1727, in the time of Pourfour-du-Petit, it was observed that after excision of the cervical portion of the sympathetic nervous system the eye became softer. This condition was attributed by Abadie to the stimulation of the vasodilator fibers of the ocular blood vessels, and he suggested (1898) section of the sympathetic nervous system for relief of the tension. Resection of the superior ganglion of the cervical portion of the sympathetic nervous system was soon after performed by Jonnesco; this proved successful in reducing the tension.⁸⁵

In 1898 Abadie⁸⁶ showed that one of the functions of the sympathetic nervous system is to regulate the tension of the intra-ocular fluid.

81. Vele, M.: Sui rapporti tra arteriosclerosi e glaucoma, *Ann. di ottal. e clin. ocul.* **61**:511 (July) 1933.

82. Hertel, E., cited by Cordes, F. C.: Early Simple Glaucoma: Its Diagnosis and Management, *Arch. Ophth.* **17**:896 (May) 1937.

83. Weinstein, P.: The Relationship Between Glaucoma and Cardio-Vascular System, *Orvosképzés* **24**:632, 1934.

84. Block, E. B., and Oppenheimer, R. H.: Comparative Study of Intraspinal Pressure, Blood Pressure and Intra-Ocular Tension, *Arch. Neurol. & Psychiat.* **11**:444 (April) 1924.

85. Jonnesco, cited by de Schweinitz, G. E.: The Physiology of the Sympathetic in Relation to the Eye, in the Relation of the Cervical Sympathetic to the Eye, papers read before the Section on Ophthalmology of the American Medical Association at the Annual Session, New Orleans, May 1903, Chicago, American Medical Association Press, 1904, p. 21.

86. Abadie, C.: Considérations sur la pathologie du grand sympathique, *Clin. opht.* **27**:303, 1923.

Soon after, Weeks⁸⁷ collected data for four cases of simple chronic glaucoma. In two the superior ganglion on one side of the neck was removed, and in the other two both superior ganglions were excised. All the patients showed a moderate degree of tension.

Four years later, Henderson and Starling⁸⁸ demonstrated that the sympathetic nervous system possesses vasoconstrictor fibers which terminate in the uveal blood vessels, stimulation of which causes constriction of the intra-ocular blood vessels.

The experiments of Bistis⁸⁹ on rabbits (1913), however, revealed that the function of the sympathetic nervous system in regulating the ocular tension is not decisive. He found that its action was only temporary. He concluded that it might be the first step in the development of glaucoma, provided a suitable terrain was present, such as rigidity of the sclera, errors of refraction, arteriosclerosis or an endocrine disorder.

There is no question, however, that a nervous element is associated with the increase of tension. I have frequently observed marked reduction in the intra-ocular tension in cases of accommodative strain which became normal after the refractive error was corrected. It has also been observed that emotion and nervous excitement predispose one to attacks of glaucoma and that there is a tendency for the disease to prevail in certain neurotic families and races.

GLANDULAR DYSFUNCTION AS A CAUSE

The theory of Heidenbein that the fluids of the body, including the lymph, are furnished by the glands prompted many observers to ascribe glaucoma to a glandular dysfunction. It is well known that stimulation of the secretory nerves of the salivary glands produces saliva at a rate far exceeding that of the intra-ocular secretion.

Hertel⁹⁰ expressed the belief that hypersecretion in glaucoma is associated with dysfunction of the thyroid. He observed that extirpation of the thyroid caused an increase of intra-ocular pressure, while the administration of thyroid produced a drop in the intra-ocular tension.

The results of Mossa's⁹¹ studies of the influence of the glands on the intra-ocular tension confirmed the opinion of Hertel with regard to the

87. Weeks, John E.: Cases of Simple Chronic Glaucoma Treated by Resection of the Superior Ganglion of the Cervical Sympathetic, *Tr. Am. Ophth. Soc.* **9**:441, 1902.

88. Henderson, E. E., and Starling, E. H.: The Influence of Changes in the Intra-Ocular Circulation on the Intra-Ocular Pressure, *J. Physiol.* **31**:305, 1904.

89. Bistis, J.: The Role of the Sympathetic in Glaucoma, *Arch. d'opht.* **47**:96 (Feb.) 1930.

90. Hertel, E.: Experimentelle Untersuchungen über die Abhängigkeit des Augendrucks von der Blutgeschaffenheit, *Arch. f. Ophth.* **88**:197, 1914.

91. Mossa, G.: Influenza di alcuni estratti ghiandolari, *Rassegna ital. d'ottal.* **3**:28 (Jan.-Feb.) 1934.

thyroid glands, but disagreed with the view that other glands have a disturbing influence on the ocular secretion.

Fuchs⁹² and Lamb⁹³ maintained that the excess of fluid in glaucoma is due to the action of the glands of internal secretion. These glands, they asserted, have an effect on the vascular system, which, in turn, regulates the amount of the intra-ocular fluid.

It is significant that most investigators stressed the origin of the ocular fluid as though it were a question of hypersecretion only. They did not take into account the fact that the outflow mechanism of the eye can take care not only of the normal secretion but also of any extra increase. It is well known that if a few drops of fluid are injected into the anterior chamber of a normal eye, the hypertension momentarily caused will soon return to normal; the amount of extra fluid that has entered the eye will soon be balanced by a corresponding increase in the outflow through the excretory channels.

It was demonstrated that the flow through Schlemm's canal, the spaces of Fontana and superior ciliary vein is able to take care of all changes that may occur in the general arterial or venous pressure. Friedenwald and Pierce⁹⁵ proved that the outflow mechanism of Schlemm's canal can take care of ten times the normal circulation with a rise in the intra-ocular pressure of only a few millimeters of mercury. Hence too much stress cannot be laid on hypersecretion as the cause of glaucoma. The increased flow of lymph appears to be the result of glaucoma rather than the cause of it.

The theory that has received universal recognition is that of retention. This depends on the obstruction of the outflow of fluid from the eye by interference with its escape at the filtration angle.

Following the discovery of Leber⁹⁴ (1873) that the ocular fluid is drained from the eye through the sinus at the angle of the anterior chamber, Knies⁹⁵ (1876) and Weber^{38b} (1877) independently observed closure of the sinus in enucleated eyes from glaucomatous patients, which they proclaimed as the initial cause of all the symptoms of glaucoma. Knies expressed the view that the closure that he observed was due to inflammatory changes in the vicinity of the trabeculum and in the canal of Schlemm, while Weber believed that the closure in his case was caused by a swollen ciliary process which pushed the iris forward through the corneoscleral aperture.

92. Fuchs, A.: Glaucoma, *Bull. Ophth. Soc. Egypt*, 1924, p. 23.

93. Lamb, R. S.: Glaucoma, *Tr. Am. Ophth. Soc.* **24**:105, 1926.

94. Leber, T.: Studien über den Flüssigkeitswechsel im Auge, *Arch. f. Ophth.* (pt. 2) **19**:87, 1873; in von Graefe, A., and Saemisch, E. T.: *Handbuch der gesamten Augenheilkunde*, Leipzig, Wilhelm Engelmann, 1874, vol. 2, pt. 1, p. 302.

95. Knies, Max: Ueber das Glaucom, *Arch. f. Ophth.* (pt. 3) **22**:163, 1876; (pt. 2) **23**:62, 1877.

Although the discovery of Knies and Weber has been demonstrated both clinically and experimentally, the subject still remains a matter of controversy not only with regard to the original cause but also as concerns its influence on the intra-ocular pressure:



Fig. 8.—Photomicrograph of the angle of the anterior chamber in a healthy eye, showing the canal of Schlemm and the ligamentum pectinatum, with lymphatic crypts at the periphery of the iris. (After Collins, in Wood, Casey A.: *American Encyclopedia and Dictionary of Ophthalmology*, Chicago, Cleveland Press, 1915, vol. 7, p. 5434.)

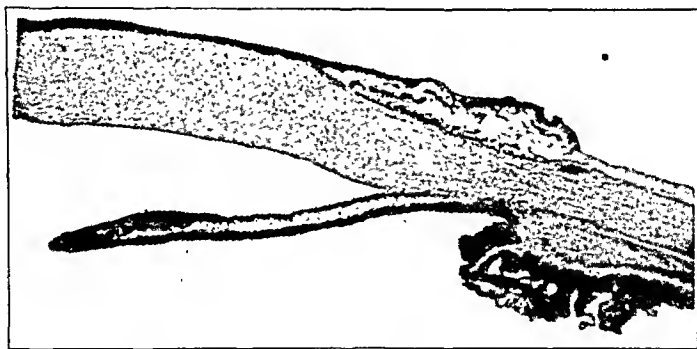


Fig. 9.—Photomicrograph of the anterior chamber of the eye in a case of primary glaucoma, showing the closure of the filtration area at the periphery of the cornea by adhesion to the root of the iris. (After Collins, in Wood, Casey A.: *American Encyclopedia and Dictionary of Ophthalmology*, Chicago, Cleveland Press, 1915, vol. 7, p. 5438.)

Hugo Tailor, in collaboration with the celebrated Italian ophthalmologist, De Vincentiis (1893), claimed that there is a direct relation between closure of Schlemm's canal and simple glaucoma.⁹⁶ These authors succeeded in reducing the ocular pressure by opening the canal of Schlemm.

De Wecker was similarly convinced that opening of the canal would reduce the intra-ocular pressure, and he strongly urged this surgical method. Recently, Barkan⁹⁷ in a paper read before the American Academy of Ophthalmology and Otolaryngology in New York strongly advocated the removal of the obstruction by opening the canal of Schlemm under direct vision made possible by his slit lamp biomicroscopy. He was of the opinion that the pressure can be brought down to normal in the largest number of cases. On the other hand, the investigations of Saltzmann, Werner,⁹⁸ Thorburn⁹⁹ and Troncoso have shown that the angle is not always closed in glaucoma, and that in the primary form of the disease it is, as a rule, entirely or partly open.

Troncoso, who studied the different stages of the disease in the living eye with the gonioscope, denied that closure of the angle is the cause of simple glaucoma. He found a lack of correspondence between the height of the ocular pressure and the condition of the angle. "There might be," he stated, "an open angle and a pressure as high as 50 mm. Hg or more." He has shown that even when the entire angle around the limbus is obliterated by an anterior synechia, the pressure may be reduced by iridectomy without opening of the angle, for the escape of the ocular fluid does not entirely depend on Schlemm's canal and the spaces of Fontana. It is also drained off by the anterior ciliary vein and the anterior surface of the iris. Troncoso⁵³ concluded that at the beginning of the disease, when the attack is not severe, the angle is always open; if the attack persists, the angle may be partially closed, and in severe cases it may be closed all around.

Parsons,¹⁰⁰ who participated in the discussion of Barkan's paper at the meeting of the American Academy of Ophthalmology and Otolaryngology, remarked: "I would like to say, however, that I do not think that all cases of glaucoma are this type at all. I think there are cases

96. Tailor, U.: Sulla incisione del tessuto dell'angolo irideo (contribuzione alla cura del glaucoma), *Ann. di ottal.* **20**:117, 1891-1892. De Vincentiis: Incisione dell'angolo irideo nel glaucoma, *ibid.* **22**:540, 1893.

97. Barkan, Otto: Recent Advancement on the Surgery of Chronic Glaucoma, *Tr. Am. Acad. Ophth.* **41**:469, 1936.

98. Werner, S.: Gonioskopie Untersuchungen bei Glaucoma primarium, *Acta ophth.* **10**:427, 1932.

99. Thorburn, A.: Gonioscopical Study on Anterior Peripheral Synechia in Glaucoma, *Dissert.*, Stockholm, 1927; cited by Troncoso,⁵³ p. 561.

100. Parsons, J. H., in discussion on Barkan,⁹⁷ pp. 486-487.

of glaucoma in which there is probably blockage of the angle of the anterior chamber, but the cause is such that the mere opening of the anterior chamber by any mechanical means is probably doomed to failure. We have to get further down into the root of the matter."

The blockage of the angle of the anterior chamber by small, dark, pigmented particles has been observed by many investigators. Koeppe¹⁰¹ in 1916 noticed, with the slit lamp of Gullstrand, that in 80 per cent of cases of acute or chronic primary inflammatory glaucoma disintegration of the pigment epithelia ensued. The pigment appeared as small, dark, coarse particles floating about freely in the aqueous. These also attacked the ciliary body of the iris, the capsules of the lens, the marginal portion of the cornea, the lymphatic spaces and the sheets of the lymphatic vessels. The presence of granules of pigment in the eye was considered by Koeppe to be pathognomonic of primary glaucoma. Because of their coarseness they obstructed the lymph channels and blocked the outflow of the aqueous.

The presence of granules of pigment blocking the pores of the trabeculum and their effect on the rise of tension were also observed by Barkan.⁹⁷

Greeves¹⁰² noticed in a group of cases of glaucoma that the spaces of Fontana were blocked by large swollen cells apparently phagocytic in nature.

The presence of pigment deposits is most likely caused by sclerosis or by atrophic changes of the pigment epithelium of the iris and capsules of the lens. Operative intervention in cases in which the pores of the trabeculum are closed with granules of pigment will probably be of no permanent benefit, since their presence in the aqueous will soon block the channels again. Deposits of pigment in the eye can scarcely be the original cause of glaucoma, since they are frequently observed in healthy eyes of the aged. The correlation lies in the fact that deposits of pigment, as well as glaucoma, are coincident with the degenerative changes characteristic of old age. Their presence, however, should be looked on with suspicion as a prodrome of glaucoma.

Meesmann¹⁰³ and Biffis¹⁰⁴ maintained that alkalinity of the blood leads to glaucoma. The presence of superabundance of protein in the

101. Koeppe, L.: Die Rolle des Irispigments beim Glaukom, *Ber. ii. d. Versamml. d. ophth. Gesellsch.* **40**:478, 1916.

102. Greeves, R. A.: Case of Partial Oculomotor Paralysis, with Synchronous Clonic Contractions of Muscles Supplied by the Third Cranial Nerve, *Proc. Roy. Soc. Med. (Ophth. Sect.)* **6**:23, 1912-1913.

103. Meesmann: Alkalinity of the Blood and Intra-Ocular Pressure, *Russk. arch. oftal.* **7**:786 (July) 1930.

104. Biffis, A.: L'alcallescenza del sangue nei glaucomatosi, *Ann. di ottal. e clin. ocul.* **61**:109 (Feb.) 1933.

ocular fluid was suggested by Duke-Elder and other investigators as a possible cause of glaucoma.

Fischer and Thomas¹⁰⁵ ascribed the etiology of glaucoma to chemical changes in the tissue of the eye itself whereby certain substances (particularly acid) capable of increasing the affinity of the colloids of the tissue for a larger amount of water were formed. Their theory differs from that of hypersecretion in the fact that it maintains that the ocular fluid does not originate in the blood vessels, lymph spaces or ciliary body but is due to the changes occurring in the intra-ocular contents which causes an increased amount of water to be absorbed. Thomas found that a subconjunctival injection of sodium citrate neutralized the effect of the acid in the contents of the eye and causes the tension to decline.

SUMMARY AND CONCLUSIONS

In reviewing the history of glaucoma one is impressed with the fact that throughout the ages this disease has presented a difficult problem the solution of which engaged the serious attention of the physician of ancient times as it does that of the modern student of ophthalmology. The tremendous amount of research done within the last hundred years to discover the etiology of the disease has disclosed many pathologic conditions, some of which are sequels or intermediate causes. Others are symptoms and form a part of the syndrome by which glaucoma is recognized. The original cause of primary glaucoma, however, still remains a problem.

Years ago, when the diseases of the eye were still in the province of the general practitioner, glaucoma was considered a local manifestation of a constitutional disorder, as albuminuric retinitis and diabetic retinitis are now considered. Gout, rheumatism, arthritis or some other condition was taken to be the original cause. The treatment was directed at the original cause, and the name and classification of the disease were based on its etiology, viz., arthritis ophthalmia, gouty ophthalmia and rheumatic ophthalmia.

With the invention of the ophthalmoscope the attention of the ophthalmic surgeon, with few exceptions, was focused on the eye as an independent unit. The numberless theories proposed to explain the original cause of glaucoma were confined to the eye. They proved to be, however, explanations of the exciting cause rather than of the original etiology, and the course of treatment, both medical and surgical, was directed to abate the troublesome symptoms rather than to combat the original cause.

105. Fischer, M. H.: Ueber Hornhauttrübungen, Arch. f. d. ges. Physiol. **127**: 46, 1909. Thomas, H. G., and Fischer, M. H.: The Relief of Glaucoma Through Subconjunctival Injection of Sodium Citrate, Ann. Ophth. **19**:40, 1910; cited by Ball, J. M.: Modern Ophthalmology, Philadelphia, F. A. Davis Company, 1913, p. 563.

The name glaucoma has become a meaningless label, since ophthalmologists no longer recognize the color of the pupil as of diagnostic importance. The classification of the disease as taught in the textbooks is doubly misleading, as the term primary, which signifies first in origin and implies that the excess of fluid in the eye arises without any antecedent cause, is contrary to the very conception of physical science. Indeed, since the use of the slit-lamp, in one half of the cases of apparently simple glaucoma the condition is recognized as having an inflammatory basis by deposits seen on the posterior surface of the cornea and over the iris and lens. According to Redslob,¹⁰⁶ glaucoma, in all cases, is secondary. "If it does not occur as a sequel to iridocyclitis and if it is not caused by lenticular changes or by tumors, it is secondary to intra-ocular circulatory disturbance."

The conclusion to be drawn from the discussion is that primary glaucoma must be looked on as an ocular complication of some organic or constitutional disease the nature of which is still unknown. The fact, however, that the disease is almost always associated with advanced age offers a clue that the etiology is bound up with the wear and tear of the body which accompany the declining years of life.¹⁰⁷

Since the most frequent degenerative change of old age is arteriosclerosis, primary glaucoma may be related to pathologic changes in the vascular structure of the body. Such changes in the larger vessels and capillaries were found in patients of the age when primary glaucoma is frequent. The pathologic changes consisted of retardation of the general venous circulation and cellular infiltration in and around the capillaries and lymph spaces. Vascular changes are particularly apparent in the eye, principally in the ciliary process, which is rich in terminal veins.

In glaucoma the veins are particularly affected. The disease is more frequent among women than among men, since the former are more liable to venous congestion. I have noticed also a striking association between varicose veins and glaucoma among male patients.

The damage done to the venous circulation causes hypersecretion of the ocular fluid, and the venous stasis causes swelling of the ciliary processes, which results in narrowing the circumlental space and the subsequent blocking of all communication between the vitreous and the anterior chamber.

106. Redslob, E.: Le glaucome primitif est-il une affection inflammatoire? *Ann. d'ocul.* **172**:1 (Jan.) 1935.

107. Knapp, Herman: Caries and Necrosis of the Walls of the Orbit, *Tr. Am. Ophth. Soc.*, 1889, p. 319. Zentmayer, W., and Posey, W. C.: A Clinical Study of One Hundred and Sixty-Seven Cases of Glaucoma Simplex, *Arch. Ophth.* **24**:378, 1895.

Some observers have noticed sclerosis of the trabeculum and thickening of the ligamentum pectinatum, which resulted in the obstruction of Schlemm's canal and the spaces of Fontana.

Other pathologic conditions of the eye which are characteristic of old age are the presence of deposits of colloid and pigment on Descemet's membrane, the anterior capsule of the lens, the vitreous and the lamella of the choroid. Such deposits are particularly frequent in glaucomatous eyes. They have been noticed in the spaces of Fontana and in Schlemm's canal. In some cases they blocked the drainage of the ocular fluid.

But while in all probability arteriosclerosis is at the basis of the disease, a glaucomatous attack is precipitated only when the resistance of the aged is weakened by disease and by physical and mental strain.

Lagrange, who is best known for his surgical devices for the relief of hypertension, struck the right chord when he stated, "The eye attacked by hypertension is a sick eye in a sick body and is not merely a hypotonic organ but also a sclerosed, dystrophic organ that shares the trouble with the rest of the body."

INTRACAPSULAR CATARACT EXTRACTION

REPORT OF A FURTHER SERIES OF CASES

LEIGHTON F. APPEEMAN, M.D.

PHILADELPHIA

The purpose of this paper is to report the results of my experience with intracapsular cataract extraction in a third series of cases, covering the period from my last report, March 1935, to November 1937. This series includes 268 cases from the wards of the Wills Hospital, in 250 of which there were no complications and in 18 of which complications were present, and 72 cases from private practice.

The Knapp method was used in all cases, as it is, in my opinion, one of the simplest methods and the freest from all unnecessary details for its accomplishment.

The beginner in the practice of ophthalmology who is fortunate enough to observe the results of various types of operation for cataract will select that method which appeals to him most strongly. The repetition of the same technic will render the operator proficient in its performance.

In spite of the fact that a description of the technic may seem trite to the experienced operator, for the benefit of those beginning the study of ophthalmology, and in the hope that instructive criticisms or experiences with other methods may be brought out, I shall repeat it.

TECHNIC OF OPERATION

After the production of akinesia to prevent spasm of the orbicularis muscle and the administration of a solution of atropine to dilate the pupil, corneal section is made as nearly through the limbus as possible, with no, or with a very narrow, conjunctival flap. The more I use this incision the better I like it, as little or no bleeding occurs to flood the anterior chamber and healing is perfectly smooth if care is taken with the toilet of the wound at the end of the operation to guard against shreds of iris tissue, conjunctiva and blood clots being included in the wound.

Iridectomy is then done, the iris being grasped near its free border, withdrawn and cut with the blade of the iris scissors held at right angles to the wound. This will give a small narrow space, sufficient for the free passage of the lens, and it will be less likely to cause the patient annoyance from glare than a large coloboma. I mention this because it not infrequently happens that a resident, working under my direction, is inclined to cut with the scissors blade parallel with the wound.

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which, with the iris drawn well out, will give a broad coloboma, such as is desired in operations for glaucoma but which is unnecessary for cataract extraction and very annoying to the patient subsequently on account of glare.

Should bleeding occur after iridectomy the anterior chamber should be flushed out at once and bleeding allowed to cease before one proceeds, in order that one may see and control the grasp of the forceps on the capsule.

With the Arruga or the Kalt forceps, the capsule is grasped in its lower third if possible, and gentle traction is exerted upward and forward and from side to side until the zonule ruptures below and the equator of the lens presents in the pupillary space. At this time it is my custom to let go of the capsule and to grasp a slightly curved spoon in each hand; the lower spoon is used to make pressure on the cornea below the lower equator of the lens causing it to rotate upward or tumble, and at the same time the spoon in the left hand is used to make slight downward pressure near the edge of the upper lip of the wound as the lens presents. Following the lens upward by an even pressure from below causes it to be delivered without difficulty as a rule.

Some operators, instead of relinquishing the grasp on the capsule, draw the lens upward and out at once. This is a point in technic which will be entirely a matter of individual preference. To me it would seem awkward, and should the capsule tear in delivery it would seem more difficult to get rid of the freed cortex and the remainder of the capsule.

After delivery of the lens, careful reposition of the iris is done, the operator stroking downward but not too deeply, to free the pillars of the iris, and then upward to clear the lips of the wound. The eye is closed after a drop of atropine solution is instilled.

In attempting this type of operation, one has the satisfaction of knowing that if the capsule tears before the zonule is broken, a considerable portion of the anterior capsule is removed in the grasp of the forceps, and the procedure may then be completed as in the older, classic type of operation. In this case an irrigator should be used to flush out as much cortical remains as possible.

With increasing experience, one can often determine the probability of seizing the capsule, although this is not always possible. The intumescent mother-of-pearl type of cataract usually cannot be grasped, although there is no reason why an attempt should not be made.

The intracapsular operation is particularly desirable in cases of nuclear and incomplete cortical cataract in which with the older technic it is difficult to get rid of soft and often sticky cortical substance by irrigation. A mature cataract can be removed readily after the stage of primary swelling, as can be judged by direct examination and by the depth of the anterior chamber. The use of the intracapsular operation is questionable for patients with very prominent eyeballs but without myopia of a high degree, as for them the danger of loss of vitreous is greater, especially if they do not give perfect cooperation. The same may be said, but with greater emphasis, about patients with a high degree of myopia, as the vitreous may be fluid and other changes may be present in the deeper structures. The use of the operation is also questionable for persons with only one eye, particularly elderly persons in whom

there may be arterial changes which predispose to hemorrhage, and for patients with cardiorenal vascular disease. I do not hesitate to attempt intracapsular extraction on persons with diabetes, after a check-up on the blood sugar and its reduction to normal range.

Cataracts associated with evidences of preceding iritis or iridocyclitis are usually not amenable to removal by the intracapsular method. They may have a very dense capsule due to the deposition of inflammatory products. In such cases the amount of traction necessary to break the zonule may do damage to the deeper structures of the uveal tract; such traction had better be discontinued and a cystotome employed, followed by expression of the cataract and irrigation.

I have had no experience with conjunctival flap sutures, corneal sutures or rectus muscle stay sutures. They would complicate the technic for me.

RESULTS

The following results were obtained in my third series of cases:

In 146, or 58.4 per cent, of the 250 cases in which there were no complications the intracapsular method was performed, either by my assistants, the resident or myself. Vision of 6/12 or better was obtained in 98 cases, or 67.1 per cent, as follows: vision of 6/6 in 37 cases, vision of 6/9 in 38 cases and vision of 6/12 in 23 cases. These results would have been better if all the patients had returned for a check-up; about 56 did not return after leaving the hospital, probably because they lived at a distance or on account of the infirmities of age, and therefore their results are those recorded just before discharge.

In 104 of the 250 cases the classic method of operation was used. Vision of 6/12 or better was obtained in 80 cases, or 77 per cent, as follows: vision of 6/6 in 20 cases, vision of 6/9 in 44 cases and vision of 6/12 in 16 cases.

In the 72 cases from private practice in which the intracapsular method was used, vision of 6/12 or better was obtained in 63, or 87.5 per cent, as follows: vision of 6/6 in 42 cases, vision of 6/9 in 20 cases and vision of 6/12 in 1 case. An expulsive hemorrhage occurred in 1 case, with loss of the eye.

Dr. Robb McDonald, the present senior resident at the Wills Hospital, in collaboration with Dr. Alfred Cowan in a study of the late results of various types of cataract operations, called in many patients who had been operated on from one to four years previously to determine the condition of the eyes after those intervals. Of 52 eyes examined on which intracapsular extraction was done, there was an improvement in vision over that last recorded in 22; vision was unchanged in 18 and was slightly less in 12.

In addition to the 250 cases in which there were no complications, there were 18 cases in which the outcome was quite different. The

intracapsular operation was performed in 13 of these and was considered a failure in 12 because of the following complications: iridocyclitis, ending in phthisis bulbi, 2 cases; hemorrhage, due to the patient getting up shortly after operation, followed by panophthalmitis, necessitating enucleation, 2 cases; detachment of the retina, 1 case; detachment of the choroid, 1 case (reattachment occurred later but the visual result was not recorded); macular choroiditis, 1 case; chronic glaucoma, 1 case; cardiac failure, with sudden death, 2 cases (in 1 four days after operation and in the other twelve days after operation), the eye being in good condition, and loss of considerable vitreous, 2 cases. The patient in 1 of the last 2 cases did not report again after discharge, and the other, a deaf person, could not hear well enough to cooperate properly. In the additional case the patient, a man of 86, was lost from observation, and vision was not recorded.

The extracapsular extraction was performed in 5 cases and was considered a failure because of the following complications: iridocyclitis, 1 case; central retinochoroiditis, 1 case; optic atrophy secondary to cataract with secondary glaucoma, 2 cases, and chronic myocarditis, with sudden death eleven days after operation, the eye being in good condition, 1 case.

Personally, the intracapsular operation is the method of choice in cases in which there are no complications because of the smoothness and rapidity of convalescence, the absence of reaction and the visual results obtained. At the first dressing, forty-eight hours after the operation, the eye usually shows scarcely any reaction, the pupil is clear and the eye remains quiet throughout convalescence. The patient can be discharged as early as the eighth day in many instances and has the satisfaction of knowing that no further operation is necessary.

From a review of the three series of cases reported since I began to use the intracapsular procedure, I find that the following visual results were obtained: In the first series of cases, reported Nov. 17, 1932, 67.02 per cent of the patients obtained vision of 6/12 or better.¹ In the second series of cases, reported March 21, 1935, 77 per cent of the patients obtained vision of 6/12 or better.² In the present series of cases 70.7 per cent of the patients in the ward and 87.5 per cent of the private patients obtained vision of 6/12 or better.

I consider these results very satisfactory, especially in view of the fact that a great many of the patients in the ward were poor surgical risks.

308 South Sixteenth Street.

1. Appleman, Leighton, F.: Intracapsular Cataract Extraction by the Knapp Method: A Report of One Hundred Cases. *Arch. Ophth.* 9:907 (June) 1933.

2. Appleman, Leighton F.: Intracapsular Cataract Extraction by the Knapp Method as Compared with the Classic Procedure: A Further Report, *Arch. Ophth.* 14:249 (Aug.) 1935.

DISCUSSION

DR. ROBB McDONALD: I should like to say a few words about the investigation which Dr. Cowan and I have been carrying out and to which Dr. Appleman referred in his paper. We are interested in the changes in the anterior segment of the eye as examined under the slit lamp and the changes in visual acuity several years after the operation. Letters were sent to 750 patients who had undergone operations for cataract at the Wills Hospital during the period from 1933 to 1935. All patients with traumatic cataract, cataract with complications and cataract associated with glaucoma and those patients known to have lesions in the posterior segment of the eye were excluded from the series. The response from the patients was poor, and we have examined only 156 aphakic eyes. This study included an examination with the slit lamp and refraction.

When we have investigated an additional series of patients our findings will be reported in full and more definite conclusions can be made, but for the present our conclusions are as follows:

1. After intracapsular extraction for cataract the hyaloid membrane bulges forward into the anterior chamber for the first few weeks; later it becomes flatter and does not protrude through the pupillary space. In many cases there is a rent in the hyaloid membrane, with subsequent herniation of vitreous into the anterior chamber. In such cases the vision did not appear to be affected.

2. In the aphakic eyes which had been subjected to intracapsular extraction no changes were found in the hyaloid membrane suggestive of increasing density of the membrane or of its becoming less transparent. In fact, in most cases the visual acuity was the same or better than that found at the original refraction.

3. An incision which is limbal throughout gives a better healing scar than one which is further forward on the cornea.

In those cases in which preliminary iridectomy was performed there were far fewer incarcerations of the pillars or anterior or posterior synechia (in extracapsular extractions) of one or both pillars.

4. The appearance of the capsule at extracapsular extraction is no index of what the visual acuity may be. In many cases slit-lamp examination showed the pupillary space to be filled with clusters of Elschnig bodies and strands of opaque capsule, yet on refraction nearly normal or normal vision was obtainable.

5. So far in our investigation we have found slightly better vision in those eyes subjected to intracapsular extraction than in those subjected to extracapsular extraction.

DR. EDWARD BEDROSSIAN: In two of the five medical mission hospitals in India where I served as associate ophthalmologist last year the intracapsular method of cataract extraction was used as a routine operation.

The first problem was the selection of proper subjects for this type of extraction. All those with juvenile cataract, prominent eyes (called ox eyes in India), cataract complicated with uveitis, synechiae, discoloration or ectasia of the sclera, or cataract associated with glaucoma were excluded.

Secondary glaucoma due to hypermature cataract was extremely common. Many patients were totally blind in both eyes on account of hypermature cataract with absolute glaucoma.

In Lalitpur my associates and I employed Sir Henry Holland's technic, with the addition of the O'Brien method for paralysis of the orbicularis muscle. Tension of all eyes was taken twice at the operating table with the Schiötz tonometer as a routine measure, and if tension was found to be above 25 mm. of mercury, the patient was considered unsuitable for intracapsular extraction; with from 10 to 50 patients with cataract reporting daily for operation, there were still plenty on whom the intracapsular method could be performed.

With this method, after limbal incision and the usual iridectomy are carried out, the eyelid speculum is removed, and the patient is told to look straight up. The upper lid is lifted away from the eyeball by a broad lid elevator and held in this position by the assistant. While the patient looks straight up, the eyeball is steadied with a small oval spatula applied below the limbus, and the zonule is broken at the lower limbus by gentle stroking with the Smith hook. This makes the lens tumble and come out without the use or aid of the capsule forceps. Occasional loss of vitreous is due to the patient's looking down instead of straight up during the extraction of the lens or toilet of the wound. When the extracted lens jams in the upper fornix, it is easily removed with a small spoon or spatula. After reposition of the pillars of the iris and toilet of the wound, a dressing moistened with mercury bichloride in a concentration of 1:2,000 is used.

In Coimbatore, Dr. S. Qurubatham has developed a very complicated and elaborate technic of his own which is quite different from that described.

As a routine procedure, he injects pontocaine in a concentration of 1:500 into the orbicularis muscle and the ciliary ganglion. Epinephrine is injected subconjunctivally, the pupil is dilated with homatropine, the superior rectus suture is used to rotate the eyeball downward and the assistant holds it in the most desirable position throughout the operation. He finishes his limbal incision with a small conjunctival flap. If the lens and vitreous move forward toward the incision, he uses a flap suture before extraction. He breaks the zonule with the Smith hook at the lower limbus, and then with his own special capsule forceps pulls the lens out with great care through the intact pupil. After reposition of the iris and careful toilet of the wound, he reflects the conjunctival flap backward, and with a Barraquet iris forceps and iris scissors performs a small peripheral iridectomy. Peripheral iridectomy after simple extraction checks the danger of postoperative prolapse of the iris into the incision.

His handling of the eye is so masterly and gentle that there is hardly any traumatism. On the third day, when the dressing is changed and the eye inspected, there is a rapidly healing wound in perfect apposition and a clear round pupil.

I had seen simple extracapsular extractions followed by peripheral iridectomy performed at Moorfields in London and elsewhere, but I had never seen the elaborate intracapsular technic of simple extraction which gave such excellent results in Dr. Qurubatham's skilful hands.

Whether in Europe, in India or in America, I feel that intracapsular extraction in all selected cases in well trained hands should be the

operation of choice, and I admire the remarkable ease and skill with which Dr. Appleman performs this operation.

DR. GEORGE CROSS: It has been interesting and instructive to hear this excellent paper, and I hope that Dr. Appleman will report the results obtained in his next series of cases.

In May 1929 I started using the intracapsular method of cataract extraction, following the Knapp-Török-Stanculeanu technic. I am still using it and am quite enthusiastic about it. I know that Dr. Appleman does not favor the use of conjunctival flaps. I do, and I feel much safer when, in addition to operating in selected cases, I suture the flap down. It is a part of my routine to do a peripheral button hole iridectomy for many reasons. I think that many operators do not do this because of the difficulty in grasping the iris properly. This is overcome by the use of the Hess forceps.

Loss of vitreous can be avoided at times by the use of more pull and less push in rupturing the zonula and by tending to preserve the hyaloid membrane. If after the zonula is ruptured the lens is soft and tends to assume a spherical shape, I do not let go the capsule but deliver it without further manipulation.

Retrobulbar or muscle cone injection of procaine hydrochloride is of great value in my hands. Since the visit of Dr. Arruga to Dr. Shannon's clinic at the Jefferson Hospital, I purchased his specula and have been suturing the superior rectus muscle tightly to hook on the upper bar, and so far I am greatly pleased with the results obtained.

I was interested in reading some time ago a statement by Dr. A. Fuchs about the danger of leaving a stringy fiber of cotton in the eye.

I still believe that the younger operators should perfect the extracapsular technic first and then when proficient select cases in which to use special methods.

DR. EDMUND B. SPAETH: In regard to releasing the capsule forceps, many authorities have suggested that patients with cataract be divided into two groups. The first group is made up of those suspected of having a fluid vitreous. In operating on such patients it is suggested that the hold of the capsule forceps be maintained and be used to aid in pulling out the lens. The second group consists of persons considered to have a healthy vitreous. In operating on these patients it is suggested that the forceps be released and the lens expressed with spoon and hook, thus making use of the hydrostatic state of the vitreous.

DR. APPLEMAN: The delivery of the lens by pressure or traction can be done with equal facility by individual operators who are experienced. One must quickly determine which method is best in the given case.

Regarding the use of a cotton-wrapped applicator in cleansing the debris from the site of operation, it is preferable to moisten the cotton slightly before use in order to prevent loose strands becoming entangled in the wound and inducing or favoring secondary infection during healing.

As to iridectomy, a small peripheral iridectomy is all that is necessary for safe delivery of the lens.

Simple extraction, without iridectomy, has been disappointing to me because of the frequency of incarceration of a knuckle of iris in the wound after the operation. If this does not occur, the result is ideal, but my experience has led me to abandon it.

THE DOMINANT EYE

ITS CLINICAL SIGNIFICANCE

WALTER H. FINK, M.D.

MINNEAPOLIS

The role which the dominant eye plays in ocular functions is as yet not fully determined. Although it has been recognized as being present, ophthalmologists have been indifferent as to its importance and the part it plays in maintaining normally coordinating eyes. The dominant eye may be defined as that eye which performs the major function of seeing, being assisted by the less dominant fellow eye. To state it differently, the two eyes do not affect the visual consciousness with equal force. One eye leads the other, and this leading eye is called the dominant eye. Just as the two hands are unequal in response, both from a motor and from a sensory standpoint, so are the eyes. Just as a person may be right handed or left handed, so he may be right eyed or left eyed.

Ocular dominance has not been found mentioned earlier than 1593, in Giovanni Battista della Porta's "De refractione." He was apparently the first to refer to the phenomenon. Beginning with the writings of Donders, more frequent references began to appear in the literature. Later reference to ocular dominance was made in the writings of Humphrey in 1861 and in an article by Callan in 1881. Rosenbach and Wray published articles on this subject in the same year (1903), and since 1918 reports of other studies have appeared.

That the human organism is one sided has been long recognized, and many data have been accumulated to support the claims of numerous investigators as to the clinical importance of sidedness. Its significance from the clinical standpoint is therefore well established. The mechanism involved, the importance of maintaining this dominancy and the consequences entailed in disrupting it are fairly definitely known. Such an understanding concerning the importance of ocular dominancy should exist.

Many writers would have one believe that eyedness and handedness are fundamentally the same process, both having a common mechanism and significance. They explain the necessity for eyedness on the same

From the Department of Ophthalmology, University of Minnesota.

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basis as manual dominance; namely, one cerebral hemisphere must dominate the other, because when this dominance is disrupted incoordination ensues. Can one assume that eyedness and handedness have basically the same physiologic mechanism? It is recognized that the dominant hand is essential in order to carry out highly coordinated actions. Is it of equal importance that one have a dominant eye to carry out the intricate tasks which civilization has imposed on the eyes? One is led to believe from the literature that ocular dominance is essential for the smooth coordination of the eyes and that when it is not present ocular imbalance and discomforts result. Ophthalmologists are advised to test the ocular muscles with the Maddox rod always before the less dominant eye and to prescribe a prism over this eye; they are told that dominance is a favoring condition for the development of motor skill, fine visual discrimination and high achievement in general.

In considering ocular dominance, therefore, one is confronted with a problem which may be of academic interest only. But, on the other hand, can it not be of more or less clinical significance? As the matter now stands, one finds little from which to form an opinion and practically no clinical statistics or data with which to substantiate an opinion. A survey of the rather extensive literature reveals that practically all the material on this subject has been contributed by nonmedical investigators, and of the oculists who have contributed, few have substantiated their claims with case reports. It is evident that one who is searching for facts and is skeptical cannot be satisfied with the data available.

It therefore seems justifiable to investigate further the problem of ocular dominance with the hope of clarifying it to some degree and of assisting in establishing some facts which are based on tabulated data. Two hundred consecutive cases in which refraction was done were analyzed. This number was believed sufficient to obtain data which may be suggestive. Consecutive cases were taken because they would simulate more closely the cases encountered in daily practice. In the course of the investigation it was necessary to discard 75 because they did not lend themselves to the problem. This discarded group was comprised of cases of amblyopia in which the good eye was obviously dominant, in which the cooperation was poor, in which the imbalance was very defective and in which the fusion was extremely poor. To present selected cases in which pronounced deviations were present would not have served the purpose because the answers of the subjects would have been obvious. The 125 cases used for this analysis therefore represent an average group of cases encountered in which the role of ocular dominance is rather uncertain.

Because of the extensiveness of the subject, the investigation was necessarily confined to a certain phase of it, namely, the practical appli-

cation of ocular dominancy to routine examination of the eyes. The problem was therefore approached from the following angles: (1) the technic for testing ocular dominancy, (2) the nature of ocular dominancy, (3) the influence of ocular dominancy on the ocular mechanism and (4) the influence of ocular dominancy in the management of ocular problems.

TECHNIC FOR TESTING OCULAR DOMINANCY

From a review of the first phase of the subject, it seems evident that there is no perfect test for the determination of the dominant eye. Many have been devised, but critical scrutiny reveals defects in all of them. When dominancy is present to a definite degree, all of the tests give fairly consistent results, but when either eye does not attain a position of definite supremacy and the dominancy of the two is approximately equal, the results of many of the tests are uncertain, and those of only two or three tests show any degree of consistency.

Because of this lack of certainty which exists as to the accuracy of the tests for dominancy, it was considered advisable to investigate first which test is most accurate and adaptable to clinical work. My object was, therefore, to find a test which is simple in technic and yet accurate.

Therefore, in carrying out this problem, the following procedures for determining, and indexes of, the dominant eye were considered: (1) the manoptoscopic method of Parson, (2) Dolman's method for both near and distant vision, (3) a modified alinement method, (4) the position of alinement at close range, (5) the convergence near point method, (6) comparison coordination tests, (7) the winking reflex and the sighting eye, (8) ocular fatigue, (9) facial asymmetry, (10) visual acuity and (11) refraction.

1. The manoscopic method of Parson's was utilized and compared with the method of Dolman. It was soon evident that this test should not be considered as a practical office test. Aside from inaccuracy and uncertainty in answers, the test requires considerable explanation before it is understood by the patient. It also lacks a feature which seems important, i. e., the objective determination of the sighting eye by the examiner.

2. The method of Dolman proved to be satisfactory. Bryngelson's¹ technic of using this method is as follows: A fiber board with a 3 cm. opening is held in both hands. The patient is asked to raise the board and sight through the opening at a small point of light 20 feet (6 meters) away. This is repeated three times with the board held at arms' length, three times with the arms slightly flexed and three times with the arms fully flexed, so as to hold the board within a few inches of the eyes. Between each sighting, the board is lowered and rested on the lap. The

1. Bryngelson, B.: Personal communication to the author.

whole procedure is repeated except that the board is carried from above. The purpose of these repeated trials from above and below is to eliminate the influence of habit as much as possible. The test is repeated, the hole in the board being lined up with a pencil point held at a distance of 2 feet (60 cm.). The purpose of this is to see whether or not there is a uniformity of dominance for distant and near alinement. The Bryngelson method proved to be very practical and lends itself admirably to office routine, as it is easily understood and results are uniformly accurate. The one objection which can be raised is that by using the hands there is a possibility of sidedness entering into the test for distance.

When this method was used in the series of 125 cases, dominance of the right eye was found in 77 cases and of the left eye in 43, while in 7 cases the dominance varied. On the basis of the average dominancy obtained by using all the tests, dominance of the right eye was found in 74 of the 77 cases and dominance of the left eye in 3, while dominance of the left eye was found in 29 of the 43 cases and dominance of the right eye in 14. When the Bryngelson method was used for near vision, dominance of the right eye was found in 73 cases and of the left eye in 43, while ambidexterity was noted in 4 cases. According to the average ocular dominancy, dominance of the left eye was found in 4 of the 73 cases and dominance of the right eye in 15 of the 43 cases.

The results with the Bryngelson modification of the Dolman method, therefore, may be considered highly accurate and fairly consistent with the combined results obtained with the other methods.

3. With the modified alinement method, the examiner holds a pencil 3 feet (90 cm.) from the patient and asks him to line up the pencil with a distant object. In so doing, the patient does not utilize the hands, and the dominant eye is determined by covering one and then the other eye and observing which remains in alinement. The factor of sidedness is eliminated, which is considered by some a serious objection and which is found in the other tests mentioned. However, this test proved difficult to explain to the patient. When this test was used in the series of 125 cases, dominance of the right eye was found in 83 cases and of the left eye in 41, while ambidexterity was noted in 1. A comparison of these results with the average eyedness showed that in 6 of the cases in the first group the left eye was dominant and in 15 of the cases in the second group the right eye was dominant.

Compared with the Bryngelson method, this test did not show any appreciable higher degree of accuracy and was certainly more difficult to carry out.

4. For the test which is based on the position of alinement of objects held at close range, the patient, holding a card, is asked to direct his gaze

at a small number on the card. The observer notes with which eye, if any, the object is in better alinement. The card was alined with the right eye in 33 cases and with the left eye in 22 cases, while in 71 cases it was held in the midline. In a comparison of these figures with the average eyedness, it is noted that in 4 of the cases in the first group the left eye was dominant and in 12 of the cases in the second group the right eye was dominant. This test is but suggestive and not highly accurate.

5. The convergence near point test is performed by asking the patient to fix his eyes on a minute object, which is carried slowly toward him until one eye diverges. The eye which remains fixating is considered the dominant eye. In certain cases in which the divergence was bilateral, it was difficult to determine which eye was dominant. With this test there was deviation of the right eye in 62 cases, of the left eye in 38 cases and of both eyes in 25 cases. The right eye was dominant in 31 of the 38 cases in which the left eye deviated. This test cannot be considered accurate.

6. With the comparison coordination test, the two eyes are compared as to the degree of skill in carrying out coordination acts. The more skilful eye is considered the dominant eye. In the present series of cases two tests were performed, namely, the target and the contact test.

The target test consists of inserting a pencil through a 3 cm. opening in a board placed at arms' length. The patient stands with one eye occluded before the board and holds the pencil in his dominant hand with his arm at his side. He then is asked to raise his arm and attempt to pass the pencil through the hole. This is repeated three times with one eye. This eye is then occluded, and the test is carried out in the same manner with the other eye.

The contact test is performed with an instrument which consists of a board on which is fastened two almost parallel metal strips, 16 inches (40 cm.) long, almost in apposition on one end and slightly more separated on the other end. These are connected to one pole of a battery, and a needle-like piece of metal attached to a wooden handle is connected to the other pole. The patient is instructed to pass the needle between the two metal strips without touching them. The slightest contact between the needle and the bars causes an electric current to be formed, resulting in a buzz. This is repeated three times with each eye, the dominant hand being used and the other eye being occluded.

The target test revealed dominance of the right eye in 93 cases, with right handedness in 90, and dominance of the left eye in 32 cases, with right handedness in 30. The contact test showed dominance of the right eye in 76 cases, dominance of the left eye in 36 cases and ambidexterity in 19 cases. Although these tests indicate dominancy, they are not practical as an office procedure and have the objection that the sidedness may influence the result.

7. The winking reflex proved rather unreliable as a method of determining the dominant eye. It was difficult in many cases to determine which eye was the winking eye. In the series of 125 cases 35 patients winked the right eye, 33 winked the left eye and 57 winked either eye. When these figures were compared with the average eyedness, it was noted that in 12 cases in which the right eye was winked the left eye was dominant, and in 27 cases in which the left eye was winked the right eye was dominant.

Closely related to this test is the determination of the sighting eye. In 93 cases the sighting eye was the right eye, and in 33 cases it was the left eye. According to the general average, the left eye was dominant in 13 of the 93 cases and the right eye was dominant in 15 of the 33 cases.

It is also interesting to note that the right eye was dominant in 10 of 91 patients who used the right eye for shooting.

8. The possibility of ocular fatigue as a factor in the determination of the dominant eye was investigated. In 37 cases the right eye was named as the eye experiencing the greater fatigue on use, and in 7 of these cases the left eye was dominant. In 43 cases the left eye showed fatigue, and in 31 of these cases the right eye was dominant.

9. Facial asymmetry did not seem to be significant in this series.

10. Visual acuity, although not generally considered an important factor in determining the dominancy of the eye, in this series proved to be some indication of dominancy. In 38 cases there was no difference in visual acuity, and in 27 of these the right eye was dominant. In 16 cases there was equal subnormal vision, and in 13 of these the right eye was dominant. In 29 cases one eye was normal and the other was subnormal, and in each case the better eye was dominant.

11. Refraction proved to be of some value in determining the dominant eye. In all instances the eye having the smaller error of refraction showed a high percentage of dominancy. Of 44 cases of myopia, the right eye was dominant in 29. Of 64 cases of hyperopia, the right eye was dominant in 59. Of 89 cases in which there were unequal refractive errors, the right eye was dominant in 66. Of 31 cases of astigmatism over 1 diopter, the right eye was dominant in 21.

In the summary of the methods here used to determine dominancy, results point to the fact that the Bryngelson modification of the Dolman method and the alinement method, which are numbers 2 and 3 as listed, are the most accurate. As a practical method for office use, the Dolman method appears to be more satisfactory because it is more easily understood, quickly performed and inexpensive in construction. The examiner can see the selection and registers in a high percentage of cases. As to the accuracy, it compares favorably with the alinement test, even

though some may object because of the fact that the board is held by the patient.

NATURE OF OCULAR DOMINANCY

The nature of ocular dominance is not by any means understood. Certain phases of it can be fairly well explained, whereas one must theorize in regard to others. Opinions have been expressed as to the various explanations, but much proof is still wanting. It is therefore necessary in order to gain a more correct understanding of the present status of the problem that certain phases of its nature be considered and explanations advanced.

(a) Ocular dominance is a characteristic of the ocular mechanism. In the higher forms of animals, binocular vision is associated with some form of lateral sighting. Among apes, and occasionally in ambidextrous man, this sighting faculty is not fixed but fluctuates laterally according to the position of the visual stimuli on the right or left. With few exceptions, the human race has acquired the faculty of fixed unilateral visual and manual dominance.² This probably arose when man made his first attempt to create weapons and tools and required a holding hand and monocular sighting in order to do away with double images, which otherwise would be constant and inevitable with direct and equal binocular vision. One therefore observes that in the examination of two eyes which are exactly alike in manifest and retinoscopic findings that one eye possesses a greater sense of clarity, a greater sharpness for detail and, in general, a greater power and refinement of discrimination. According to Parson and Scheidemann and Robinette,³ such dominance is absolute because only this master eye sees objects in their true place, while the impressions of the other eye are suppressed by, or lost in, the clearer image of the prevailing eye, save for those parts of the visual field, which, from their position, are seen by the weaker eye alone. These impressions, in turn, are transferred on the dominate eye in such a manner that one imagines that one is seeing through this eye all that one sees only with the weaker eye.

With suitably applied tests, the habit of ocular dominance is found to be almost universally demonstrable in some degree. In this series of 125 cases, all patients showed evidence of ocular dominance when the tests were applied. It is therefore safe to assume that in the great majority of persons there is undoubtedly, aside from normal binocular vision, monocular vision subserving binocular vision and greatly insuring the precision and accuracy of visual projection.

2. Parson, B. S.: *Lefthandedness*, New York, The Macmillan Company, 1924, pp. 39-132.

3. Scheidemann, N. V., and Robinette, G. E.: *Testing the Ocular Dominance of Infants*, *Psychol. Clin.* 21:62, 1932. Parson.²

(b) A relation exists between ocular dominance and sidedness.

According to Parson,² bilateral asymmetry of function is limited by no means to the eyes but is so uniformly present in all the paired organs of the body, in the skeletal and muscular structures and functions, in dermal and muscular sense and in all the special senses as to force the recognition that asymmetry of structure and of function is a basic condition of the human body in its present stage of evolution.

As early as 1861, Humphrey⁴ discussed the correspondence of function between hand and eye and advanced the theory that eyedness is a cause of handedness. This so-called ocular dominance theory of handedness became the subject of considerable controversy, with the result that most of the studies of eyedness have been incidental to those of handedness. Van Biervliet⁵ in 1897 showed that handedness is usually accompanied by a corresponding keenness of the optic, acoustic, tactile, olfactory and gustatory motor nerves on that side of the body. Gould⁶ expressed the belief that handedness depends on the better-seeing eye, and the right eye, usually being the better, "compels the right hand to work with it."

Parson² concluded that sighting along the right visual line by a right-handed person and along the left visual line by a left-handed person is the direct instrument in the production of sidedness. He reasoned that these visual operations which are carried on monocularly lead inevitably to the preferred use of one hand—the hand nearer the sighting eye—for the greatest anatomic and physiologic advantage. Every consideration of speed, accuracy and economy of muscular effort, and hence the development, safety and well being of the entire organism, demand this intimate correlation of eye and hand on the preferred side.

Miles,⁷ in studying left-handed adults and children of school age, and Travis⁸ in comparative studies of normal speakers and stutterers, pointed to a possible although not so invariable relation.

In 1936 Kuroda reported the results of a study of Japanese school children in whom he found no significant relation between eyedness and handedness. In a study of over 3,000 males varying in age between 6 and 81 years, Woo and Pearson⁹ found a zero correlation between

4. Humphrey, cited by McAndrews, L. F.: Ocular Dominance, *Arch. Ophth.* **13**:449 (March) 1935.

5. Van Biervliet, J.: *L'homme droit et l'homme gauche*, *Rev. phil.*, Paris **47**:113, 276 and 371, 1899.

6. Gould, G. M.: *Right-Handedness and Left-Handedness*, Philadelphia, J. B. Lippincott Co., 1908.

7. Miles, W. R.: Ocular Dominance: Methods and Results, *Psychol. Bull.* **25**:155, 1928.

8. Travis, L. E.: *Speech Pathology*, New York, D. Appleton and Company, 1931.

9. Woo, T. L., and Pearson, K.: Dextrality and Sinistrality of Hand and Eye, *Biometrika* **19**:165 (July 15) 1927.

manual and ocular dextrality. Coons and Mathias, from their study of the tendency toward ocular and manual preference, drew the conservative conclusion that persons with dominance of the left eye tend to be less right handed than those with dominance of the right eye.

However, statistics show that there is a high percentage of correspondence between the dominant side and the dominant eye. It is estimated that pure dextrality (right handedness and right eyedness) occurs in about from 85 to 90 per cent of persons; pure sinistrality (left handedness and left eyedness), in from 5 to 10 per cent, and crossed dominance or absence of dominance (ambidexterity), in from 5 to 10 per cent. Mills¹⁰ concluded that there are two types each of dextrality and sinistrality: 1. Pure dextrality consists of right handedness and right eyedness. This type occurs in about 76 per cent of all persons. 2. Pure sinistrality consists of left handedness and left eyedness. This type occurs in about 9.3 per cent of persons. 3. Crossed dextrality consists of right handedness (usually by training) but left eyedness. This type occurs in about 13 per cent of persons. 4. Crossed sinistrality consists of left handedness with fixation of the right eye and usually divergence of the left eye, though there may be divergence of the right eye. This type occurs in about 1.7 per cent of persons. According to Bryngelson,¹ who examined 400 university students, 25 per cent of right-handed subjects were left eyed, 3.6 per cent were amphiocular and the remainder were right eyed. In the series of cases here reported the findings were as follows: Of the 118 right-handed subjects, 89 were right eyed; the remainder were left eyed, and therefore showed a crossed dominance. Of the 7 left-handed subjects, 3 showed crossed dominance.

The following tabulation indicates the sidedness, the ocular dominance and the percentage of ocular dominance in the group analyzed:

Right Eye Dominant, Percentage of Dominancy	Right Sidedness, No. of Cases	Left Sidedness, No. of Cases
100	64	1
90	14	1
80	5	0
70	5	0
60	1	1
50	0	0
Left Eye Dominant, Percentage of Dominancy		
100	19	1
90	7	0
80	1	1
70	1	0
60	1	1
50	0	0

10. Mills, L.: Unilateral Sighting, California & West. Med. 28:189 (Feb.) 1928.

That these explanations of eyedness cannot be accepted without question is evident, although one is impressed with the fact that many features of eyedness suggest some points which justify some such explanation. It must be kept in mind that in certain respects the ocular functions differ from the functions of the hand. The functioning of the two motor coordinations (hand and eye) are really not analogous. For example, picking up a needle requires the use of but one hand; to use both hands for such a task would be clumsy. The needle is, however, viewed with both eyes as one reaches for it and is threaded on the basis of binocular impressions. Again, throwing is done with one hand, but both eyes remain open. It is typical, then, to use one hand or the other and habitually one, but in vision one characteristically uses both eyes, and under some special circumstance or as an aid to some particular motor skill, only one eye.

It seems logical, therefore, to conclude that more than 75 per cent of all human beings are right eyed and 23 per cent are left eyed, and in about 2 per cent ocular dominance is indifferent or is distributed between the two eyes. Practically all right-eyed persons are right sided. In the case of left-eyed persons this relation is not as constant. Many of them are right handed through training. Parson² expressed the belief that tests for ocular dominancy show the original rather than the existing conditions of handedness and that teachers, nurses, parents and associates have all conspired to turn sinistrality into dextrality. He reasons that as virtually all the right-eyed persons are at the same time right handed, one is justified in believing that the natively left-eyed persons, irrespective of their present manual preference, were all originally left handed. Cuff¹¹ has arrived at similar conclusions. In his report it is stated that from 20 to 30 per cent of the children were probably left handed natively; also that 100 per cent of the right-eyed children were found to be right handed. Various authors place the incidence of native left handedness at from 4 to 27 per cent. Undoubtedly a high percentage of natively left-handed persons have shifted to the use of the right hand.

It therefore seems evident from the information available that eyedness and handedness are to some extent related. Whether the relation is of such a degree that the one influences the other cannot be definitely stated. To accept Parson's theory that eyedness is the fundamental factor and handedness is dependent on it would greatly simplify the problem. There is no question that Parson took the subject out of the realm of speculation to a certain degree by his demonstration of the optical necessity for unilateral sighting.

11. Cuff, N. B.: Relation of Eyedness and Handedness to Psychopathic Tendencies, *J. Gen. Psychol.* **37**:532, 1930.

(c) Ocular dominance is stable.

While training, accident or disease may reverse the manuality of a person, eyedness, i. e., the exclusive use of either the right or the left visual line for sighting, persists tenaciously throughout life, severe ocular disease early in life or practical blindness in adults being necessary to cause its reversal. The conditions which would be supposed to modify ocular mastery usually produce the expected modification. Ulcers or injuries of the cornea in early childhood which have left severe scarring and disease or injury of the lens, retina, macula or choroid occurring congenitally or early in life are likely to throw the mastery to the unaffected or to the less affected eye if there is much loss of vision. Again, when a high degree of astigmatism exists in one eye, it is almost certain to be present in the eye which lacks dominance and nearly always is related to the side of the body which has the poorer function. Exceptions to this general rule are not rare in cases of myopia, in which at times the sighting eye yields first and to a greater degree than the other eye. On the basis of observations made on several thousand persons, Mills¹⁰ stated that when the special paths of binocular control and monocular mastery once are established they are not likely to be modified after adolescence by any disease or injury which still permits vision of approximately 6/20 in the affected eye. Parson stated that once dominance is acquired it is never changed by education or training. Only when the dominant eye has suffered an injury or visual depreciation can the transfer be effected. In adult life special habits or special training involving the use of one eye especially, such as prolonged unocular microscopic observations, does not determine ocular dominance and does not alter a preference already established.

Therefore, all the evidence points to the fact that, once a preference is established it can be reversed only with difficulty.

(d) Ocular dominance promotes mental stability and better coordination.

Work by Cuff¹¹ suggested that those persons who have a strong unilateral sighting tendency are the ones who are most nearly normal emotionally. His data suggest that these persons are likely to have fewer psychopathic traits. Mills¹⁰ called attention to the nervous instability of children in whom there is crossed dominance. Oates¹² found the highest percentage of speech defects in persons with crossed sinistrality, i. e., those who are right eyed and left handed. Dearborn also found numerous cases of reading disability allied with mixed dominance. According to Chandler, more psychotic than normal persons prefer a noncorresponding eye with a corresponding hand and foot.

12. Oates, D.: Ocular Dominance, *J. Gen. Psychol.* **39**:492 and 423, 1931.

Another interesting fact in connection with crossed dominance is its influence on general coordinated actions. Freeman and Chapman,¹³ experimenting with coordination of the hand and eye, concluded that skill can be acquired only to a certain degree by those who are not well coordinated as compared with those who have better coordination. According to Mills,¹⁰ persons with right manuality often are discovered to be left eyed by their indifferent or uncertain ability at golf, shooting, tennis, baseball and other types of sport. He expressed the belief that in these games, played with both eyes open, a person with crossed dextrality or crossed sinistrality is at an anatomic and physiologic disadvantage as compared with a person with pure dextrality or pure sinistrality, whose sighting line and preferred hand are on the same side and work together naturally. The intimate grouping of the principal motor centers is disarranged in the person with crossed dominance, and in the transfer of part of the activities to the other cerebral hemisphere a certain amount of indecision and awkwardness often is apparent. So long as a person with crossed dextrality does not strain and merely uses muscle sense and two-eyed vision, he shoots and plays games reasonably well, and at times very well, but when he becomes particularly anxious, by the very nature of ocular dominance he must pick up his alignment with the left eye and miss widely to the left. In other words, when exact sighting is necessary, binocular vision is replaced by monocular vision and the sight is brought into line with the object by the master eye along its line of vision. Obarrig,¹⁴ however, expressed the belief that the question of sight is of relatively secondary importance throughout the whole realm of sports and that the matter of muscle coordination, quick perception, adaptability, responsiveness, reaction to surroundings, and temperamental nature, plus other items, with or without regard to eyedness and handedness, constitute a proficient player.

Investigation of this series of cases to determine which combination of handedness and eyedness was the most coordinated showed that the coordination was the best with the target test when the dominant eye and the dominant hand were used. In an analysis of the contact test for the degree of coordination, a similar result was obtained.

The foregoing results are but suggestive. Undoubtedly it is of some advantage and promotes better coordination to have the dominant eye and the dominant hand on the same side.

(e) Ocular dominance is independent of visual acuity and refraction.

The relation of visual acuity to ocular dominance is of value in analyzing the nature of dominance. It has been found that occasionally

13. Freeman, G. L., and Chapman, J. S.: Relative Importance of Eye and Hand Dominance in a Pursuit Skill, *Am. J. Psychol.* **47**:146, 1935.

14. Obarrig, P., in discussion on Mills, L.: Eyedness and Handedness, *Am. J. Ophth.* **8**:933, 1925.

the eye with the lower visual acuity is the dominant eye. According to Bryngelson,¹ ocular dominance is not related to visual acuity or refraction, although these may be determining factors. Gahagan¹⁵ studied the ocular dominance and visual acuity of 100 persons to discover whether or not a relation exists between these two visual conditions. He concluded that superior visual acuity of a given eye is not indicative of a corresponding dominance of that eye.

The relation of visual acuity to dominance, as noted in the series of cases here reported, is as follows: The right eye was dominant in 27 of 38 cases in which the vision was normal and equal in both eyes; it was also dominant in 13 of 16 cases, in which vision was equal but below normal. The better eye was dominant in 21 of 29 cases in which the vision was normal in one eye and subnormal in the other. The dominant eye was the better eye in 30 of 40 cases in which the vision was below normal in one eye or in which it was less defective in one eye than in the other.

(f) Ocular dominance is established early in life.

The age at which ocular dominance develops is a factor in analyzing the nature of dominance. Little or no evidence is available as to when the preference for one eye first develops or whether the habit is established as a result of environmental conditions or tendencies of motor coordination. According to Schneidemann,¹⁶ impartial eyedness is more common in young children. From a comparison Schneidemann's results with those of others studying older children, indications are that impartial eyedness is more common in preschool children than in children of school age. There was no apparent difference in the incidence of eyedness on the basis of sex. It seems justifiable to believe that ocular dominance is not established in many children before the age of 3; thereafter it is commonly found.

(g) Anatomic evidence of the nature of ocular dominance is not conclusive.

McAndrews¹⁷ stated that Linebrook examined automatically 18 pairs of human eyes in an attempt to discover whether there was any structural condition in the right eye to account for ocular dominance. In every pair of eyes examined the fovea was found closer to the optic disk in the right eye than in the left. He expressed the belief that this may explain the dominance of this eye, basing his belief on the assump-

15. Gahagan, H. L.: Visual Dominance: Acuity Relationships, *J. Gen. Psychol.* **8-9**:455, 1933.

16. Schneidemann, cited by Schoen, Z. J., and Scofield, C. F.: A Study of the Relative Neuromuscular Efficiency of the Dominant and Non-Dominant Eye in Binocular Vision, *J. Gen. Psychol.* **12**:156, 1935.

17. McAndrews, L. F.: Ocular Dominance, *Arch. Ophth.* **13**:449 (March) 1935.

tion that the fovea of the right eye reaches the line of vision more quickly than that of the left.

(h) Ocular dominance does not shift when the focus is changed from distant to near vision.

In practically all the cases analyzed the same eye was dominant for both distant and near vision. For example, when ocular dominance for distant vision was tested, the right eye was dominant in 77 cases. In repeating the test for near vision, the right eye was dominant in 73 cases. In other words, no appreciable difference exists in ocular dominance for distance and near vision.

(i) Facial asymmetry is not a factor in ocular dominance.

In the present series of cases there was no relation between facial asymmetry and ocular dominance. All patients showed an average degree of facial asymmetry, and even those who showed a somewhat greater degree of facial asymmetry did not show a greater degree of ocular dominance.

(j) In cases of strabismus the turned eye is usually the less dominant eye.

In 6 cases in this series a history of strabismus was obtained. In all of these the deviating eye was the nondominant eye.

The symptom of ocular fatigue is of little significance in ocular dominance.

(k) The symptom of ocular fatigue was used as a possible index as to whether the dominant eye, being supposedly used more, would show evidence of fatigue before the nondominant eye. Analyzing this series of cases showed that the right eye was designated in 44 cases, in 31 of which this eye was dominant.

(l) The duration of wearing glasses has no influence on the degree of dominance.

This phase was investigated in the series of cases reported here. For example, of those persons who had worn glasses for less than one year, the group with the right eye dominant showed a dominance of 74 per cent, and the group with the left eye dominant, a dominance of 69 per cent; of those who had worn glasses for ten years or more, the group with the right eye dominant showed a dominance of 74 per cent, and the group with the left eye dominant, a dominance of 75 per cent.

(m) The degree of dominance does not vary appreciably in persons using their eyes to a slight degree for fine work as compared with those who use their eyes excessively.

This was found to be true in the present series of cases.

(n) Sex is not a factor in dominance.

When dominance was analyzed from the standpoint of sex the right eye was dominant in 43 of the 53 male subjects and in 51 of the 73 female subjects.

In summary, it is evident that when considering the nature of ocular dominance one is dealing with a subject which is imperfectly understood, not only as to the basic nature but as to its application to clinical problems. Whether it is a physiologic or a psychologic process is unknown, although there are some data to support both sides. One must, therefore, theorize as to its nature. There are certain characteristics of its nature which are suggestive. Ocular dominance seems to be a characteristic of the ocular mechanism, as it is uniformly present to some degree in practically all cases. There seems to be a relation between ocular dominance and sidedness. Whether one depends on the other is not known, but the explanation of Parson makes the mechanism easily understandable and in some respects logical when considered in the light of recent views put forth on sidedness. One is therefore tempted to theorize as does the pathologist who explains speech defects on the basis of a disruption of a perfect balance in the coordination of the two hemispheres. The perfect coordination which must exist in the eyes may be comparable to that of handedness and can be maintained only by the presence of a dominant eye.

Another characteristic of dominance is its stability, and like handedness it cannot actually be shifted unless the vision is greatly lessened in the dominant eye. Dominance is established apparently early in life and becomes more evident with age. Ocular dominance seems therefore to be a centrally located process rather than a peripheral one, as it is evidently not related to vision, refraction, habits and other such factors.

INFLUENCE OF OCULAR DOMINANCE ON THE OCULAR MECHANISM

Although many phases of the phenomenon of binocular vision have been investigated, relatively little is known of the fundamental mechanics of the process. Such processes as the fusion of dissimilar images and binocular rivalry are but imperfectly understood. The fact of ocular dominance has long been known, but little studied, except with respect to its incidence and its relation to handedness. Its significance in the actual mechanism of binocular vision has received scant attention. The simultaneous functioning of the two eyes is a process certain to be materially affected by the fact that one eye is functionally dominant, and in this binocular act it is highly probable that the behavior of the nondominant eye differs essentially from that of the dominant eye.

In discussing the influence of the dominant eye on the ocular mechanism, I shall assume that ocular dominance does exist. This being the case, what benefit does the ocular mechanism derive from its presence? Time does not permit the consideration of all angles of this question; so only certain phases will be discussed.

(a) Does ocular dominancy act as a stabilizer on the ocular mechanism and tend to promote binocular coordination or unity of action between the eyes?

The degree of binocular coordination or unity of action between the eyes may depend on the following factors: (1) the degree of binocular fusion or stereoscopic vision (2) the ocular muscle balance, (3) the adduction power, (4) the near point of convergence and (5) the presence of paresis of the ocular muscles. Knowing these factors, one is in a position to form some opinion as to the degree of binocular coordination.

Therefore, in attempting to answer the foregoing question these factors were investigated in the present series of cases, and the average of the results of the various tests were considered as the degree of binocular coordination. This, in a measure, gives some basis for comparison of the individual case.

1. In estimating the degree of fusion, or depth perception, three methods were employed: the red glass test, as described by Duane; the degree of stereopsis, and the degree of depth discrimination, as determined by the apparatus of Howard and Dolman. Although other tests may be used for this determination, it was believed that by using the aforementioned tests the results would be sufficiently accurate so that the data would be fairly suggestive and a comparatively accurate idea could be obtained as to the degree of fusion and stereoscopic vision.

The red glass test as described by Duane consists of placing a red glass before the right eye and asking the patient to direct his gaze to a muscle light 20 feet away. If he is able to superimpose the red and the white light, it is assumed that the fusion power is not weakened. If the two lights are not superimposed, even after a few moments' delay, it is assumed that the fusion power is poor. If the superimposing of the two lights is delayed, it is assumed that the fusion power is weakened. In this series of cases 90 of the patients were able to superimpose the two lights; 68 of these were right eyed. Of the remaining 35 who were unable to superimpose the two lights, 20 were right eyed.

The determination of the degree of stereopsis consisted of using the usual stereoscopic tests, as suggested by Worth. All of the patients on whom this test was used showed third degree fusion.

The degree of depth discrimination was determined by the test of Howard and Dolman. According to the accepted technic, 2.5 cm. of separation is considered a normal degree. Of the 119 patients showing less than 2.5 cm. of discrimination, 93 were right eyed and showed 74 per cent of dominancy. Of the 6 who showed more than 2.5 cm. of discrimination, 5 were right eyed and showed 78 per cent of dominancy.

2. The ocular muscle balance also was used as a criterion as to binocular coordination and unity of action between the eyes. The balance was taken with the Maddox rod over the dominant eye and again with the rod over the less dominant eye. In the group of cases analyzed, it was found that a definite correlation existed between the degree of ocular dominancy and the muscular balance. A higher degree of coordination of the eyes was found when the balance was within normal limits.

3. Duction power of the muscles was utilized as an indication of the degree of binocular coordination. The procedure was as follows: The adduction power was obtained by placing the rotary prism before the dominant eye, and the duction power of the horizontal muscles was measured. The rotary prism was then placed before the less dominant eye and the procedure repeated. The result tabulated was the average of three trials. The fixing object was a muscle light at a distance of 20 feet. A correlation of these findings with the degree of ocular dominancy revealed that when the abduction power was 8 degrees or over the patients showed at least 75 per cent of ocular dominancy. Likewise this was true when 10 degrees of adduction or over was considered the minimum degree of adduction.

In the tests for both adduction and abduction power, changing the prism from one eye to the other did not materially alter the results.

4. The near point of convergence was also determined in the present series of cases, and in 46 it was found to be more remote than is usually considered normal. Any figure over 100 mm. was considered remote. Dominancy had the following relation to the near point of convergence: There were 10 cases in which the near point of convergence was 70 mm.; in 8 of these the right eye was dominant, and in all there was a high degree of dominancy. There were 69 cases in which the near point of convergence was under 100 mm.; in 53 of these the right eye was dominant, and the degree of dominancy was over 75 per cent. In the cases in which the near point of convergence was under 100 mm., the average percentage of binocular coordination was 66, a much lower figure than would be expected. There were 46 cases in which the near point of convergence was over 100 mm., and in 35 of these the right eye was dominant, and there was less than 75 per cent of dominancy.

5. In a consideration of the binocular coordination and unity of action between the eyes, it is important to bear in mind the possibility of paresis of the ocular muscles. The cover test was thought to be the best method of approaching this question, but it was discarded in favor of the diplopia field test, which more graphically shows the conditions of the muscles. In the group of cases analyzed, no diplopia was noted in 43 cases, in 32 of which the right eye was dominant. Diplopia

in two fields or more was noted in 50 cases, in 37 of which the right eye was dominant. The ocular coordination in the first group was 92 per cent, and in the second group, 75 per cent.

The relation between ocular dominance and binocular coordination in this group of cases is summarized as follows: In 93 cases in which the right eye was dominant and there was an average of 75 per cent of dominance, there was binocular coordination of 91 per cent. This same relation held for the 31 cases in which the left eye was dominant, the percentage being practically the same. It therefore suggests that when dominance is definite binocular coordination is better than average.

(b) Does ocular dominance promote better unity of action between visual activity and other body activities?

According to Parson, Mills and others, it is believed that sidedness is originally determined by eyedness and that for the efficient performance of many acts in which vision and the hand enter the dominant eye is an important factor in carrying out the action efficiently.

A series of tests were performed in which the degree of coordination of the two eyes and the two hands was employed in various combinations. Two tests which called for a high degree of coordination were utilized, namely, the target test and the contact test. The tests have been previously described. In each test the following combinations were used: the dominant eye and the dominant hand; the dominant eye and the less dominant hand; the less dominant eye and the dominant hand, and, lastly, the less dominant eye and less dominant hand.

The results with the target test were as follows: In 81 cases the use of the dominant eye and the dominant hand resulted in the highest degree of coordination. The combination with the next highest coordination was the dominant hand and the less dominant eye.

The results for the contact test were as follows: In the greatest number of cases the use of the dominant eye and the dominant hand resulted in the highest degree of coordination. The next highest degree was shown by the dominant hand and the less dominant eye.

Lund¹⁸ reported a study of the relation of ocular dominance to coordination of the eyes and hands. Four groups of subjects representing the four combinations of ocular and manual dominance were subjected to the common target striking test under three ocular conditions—binocular vision, monocular vision with the dominant eye and monocular vision with the nondominant eye. The best scores were made when both eyes were used; the poorest, when the nondominant eye was used.

18. Lund, F. H.: Dependence of Eye-Hand Coordinations upon Eye-Dominance, *Am. J. Psychol.* **44**:756, 1932.

Freeman and Chapman¹³ concluded that there can be no doubt about the fact of dominance. It is apparent from these tests of efficiency in actual eye-hand adjustments. But it must be equally apparent (1) that one has binocular as well as monocular vision and (2) that high test efficiency is achieved when the two forms of vision are permitted to cooperate. It does seem evident that the dominant eye in cooperation with the dominant hand results in better coordination.

(c) Is binocular coordination greater when the dominance is more pronounced?

It was found that in 35 cases in which there was 100 per cent coordination the degree of dominance averaged 76 per cent and the right eye was dominant, and in 9 cases in which there was 100 per cent coordination the degree of dominance averaged 65 per cent and the left eye was dominant. In 11 cases in which there was 78 per cent of coordination the degree of dominance was 65 per cent. This suggests that a high degree of binocular coordination is associated with a high degree of ocular dominance.

(d) Is this binocular unity greater when the dominant eye is not suppressed?

To lessen the visual acuity of the dominant eye by improper glasses and thereby give the less dominant eye better vision may tend to weaken the binocular unity and cause symptoms, as suggested by the following case: Mrs. B., aged 45, suffered from symptoms of ocular fatigue. Examination revealed that she was presbyopic. Equal additions were given to her distance correction, which unknowingly caused the less dominant eye to see clearly, whereas, vision with the dominant eye was distinctly blurred. She was very uncomfortable until a greater addition was made to the reading correction for the dominant eye, which not only produced better vision in this eye but balanced the near points.

(e) Does ocular dominance influence convergence?

In looking at an object at close range does the nondominant eye do most of the converging, the dominant eye remaining fixed or converging very little? In nearly all textbooks binocular vision is represented and discussed on the basis of triangulation. The line joining the nodal points of the eyes is considered the base of this triangle, and the object fixed by both eyes in the median plane is considered equidistant from the two nodal points. Binocular single vision is thus graphically diagrammed and discussed as though each of the two eyes was equally dominating and directing. As a result, the most accurate fixation, from the standpoints of ease, comfort and proper location in space of any object, would occur if the object fixed was located on the median line perpendicular to the ocular base line. Thus equal amounts of accommodation and equal

amounts of actual turning in, or convergence, of each eye would result. In most cases, according to Sheard,¹⁹ no such ideally simple arrangement exists, and equal division of labor probably is not present. In cases of dominance of the right eye, simple tests show that ordinarily the object fixed is definitely located and sighted by the right eye. The visual triangle, so far as binocular single vision is concerned, is a right-angled triangle with the right angle subtended at the nodal point of the right eye. The angle merely is reversed in left eyedness.

Schoen and Scofield²⁰ expressed the same views.

In other words, in cases in which a dominant, or directing, eye exists, the dominant eye is the eye which sights or fixates the object and, all other things being equal, involuntarily acts through the function of accommodation to the end that the object is seen as distinctly as possible. The nonfixating, or nonsighting, eye, on the other hand, is not primarily involved in sighting or in the initial endeavor to see distinctly, but is the moving eye, and as such it converges to give binocular single vision and hence fulfils its function of estimation of distance and actual location of the object in space.

In the present series of cases a shifting from the midline was found in 100 cases. In 62 cases the shift was to the right, and in 38, to the left. In the first group, the right eye was dominant in 44 cases, and in the second group the left eye was dominant in only 7 cases. According to these figures the direction of shifting does not determine the dominant eye. The degree of dominancy did not seem to be a factor.

It is therefore evident that in certain cases the alinement is before one or the other eye, which means that one eye does more converging. Although one would expect the nondominant eye to do more of the converging as the object is shifted to the dominant side, this was not always so in the cases here analyzed.

In conclusion, it seems evident that ocular dominancy exerts some influence on the ocular mechanism. There is some evidence that ocular dominancy acts as a stabilizer on the ocular mechanism, because it is suggestive that the greater the dominancy the greater the ocular coordination. Some evidence points to the fact that ocular dominancy must be maintained as is, because suppressing it may cause ocular incoordination. The influence of dominancy on convergence is a factor to be considered. That certain persons aline an object before one eye more than the other was found in this series of cases, but the object was not always alined before the dominant eye.

19. Sheard, C.: Unilateral Sighting and Ocular Dominance, *Am. J. Physiol. Optics* 4:567, 1923.

20. Schoen, Z. J., and Scofield, C. F.: A Study of the Relative Neuromuscular Efficiency of the Dominant and Non-Dominant Eye in Binocular Vision, *J. Gen. Psychol.* 12:156, 1935.

THE INFLUENCE OF OCULAR DOMINANCY IN THE MANAGEMENT OF OCULAR PROBLEMS

The dominant eye, according to certain observers, is of clinical importance. Sheard, Pascal, Mills and others expressed the belief that the matter of finding the dominant eye is not merely a subject of academic interest but one of distinct practical value. They point out the importance of its influence in measuring and correcting heterophoria, its significance in correcting refractive errors, and its importance in myopia and in operations on the ocular muscles.

Because there is little in the literature to refute the various claims of this group, one must reserve an opinion. However, it is suggestive that the lack of interest in the subject on the part of ophthalmologists suggests in itself that it is of little clinical importance.

In the analysis of the cases herein presented an attempt has been made to determine in a measure the value of ocular dominancy in clinical examinations and treatment. Undoubtedly certain phases of routine investigations of the muscles are incomplete. This fact is evident because every ophthalmologist comes in contact with certain cases in which he is at a loss how to proceed, not only in the analysis but in the management. If ocular dominancy is a factor which has not been given sufficient consideration, it should be welcomed and included in clinical examinations. If it is but an interesting fact, it should be treated as such.

Therefore, to shed more light on the subject, the following questions and factors are considered:

1. In performing tests for ocular muscle imbalance, does ocular dominancy influence the procedure?

For examinations in cases of various types of phoria it has been advocated by some that the Maddox rod be placed before the less dominant eye and the imbalance determined by the use of prisms before this eye.

According to Maddox and others, each of the eyes is free to fix either the spot of light or the Maddox rod, whereas Mills¹⁰ expressed the belief that the distorting or dissociating device should be placed before the nonfixating, or the nondominant, eye, when such a condition of dominancy exists. By such a procedure the directing eye looks at the natural test object and definitely fixes it, while its mate, naturally accustomed to moving in coordination with the directing eye, will readily disclose its latency of error in this function of convergence coordination. If, on the other hand, the dissociating device is placed before the dominant eye and the naturally nondirecting eye is allowed to attempt fixation of the test object, a conflict of functions is immediately set up and an uncertain, vacillating state of affairs is present.

Sheard¹⁹ compared the amount of heterophoria manifested when the Maddox rod was placed over the dominant eye with that manifested when it was placed over the nondominant eye. He found that when the dominant eye was fixating (the Maddox rod over the nondominant eye) the degree of heterophoria was greater in 66 per cent of the cases and less in 7 per cent than when the rod was placed over the nondominant eye. It was the same in 17 per cent of cases. The degree of heterophoria was less when the fixation function of the dominant eye was destroyed by placing the Maddox rod before it. Even under such conditions it seems probable that a tendency exists for the dominant eye to regain its fixation capacity. Since under the conditions of the test the nondominant eye is also fixating, there is an inclination toward fusion of the two dissimilar images, the distance between them becoming less.

Although the foregoing statements seem logical, further substantiation is indicated. In this investigation the patients were examined as follows: the muscle balance of each patient was tested with the Maddox rod before the nondominant eye, and the amount of imbalance was measured by placing the rotary prism before this eye. Measurements were again taken with the rod and prism before the dominant eye. A comparison of the result is as follows: With the Maddox rod at 6 meters, it was found that changing it from the dominant to the less dominant eye produced a difference of less than 2 degrees in the readings, in 83 cases, whereas in 2 cases a difference of over 2 degrees was noted. The amount of imbalance was not always greater than 2 degrees with the rod before the less dominant eye. The right eye was dominant in 63 of the 83 in which a difference of less than 2 degrees was found, whereas it was dominant and there was a lower percentage of binocular unity in 32 of the 42 cases in which there was a greater degree of difference. With the Maddox rod at 33 cm., a difference of less than 2 degrees was found in 91 cases and of more than 2 degrees in 34 cases. The right eye was dominant in 70 of the 91 cases, whereas it was dominant in 26 of the 34 cases. In these cases likewise there was not always an increase in the imbalance when the rod was shifted from the dominant to the less dominant eye.

These results suggest that changing the Maddox rod from one eye to the other can produce an appreciable difference in the readings in about one third of cases, with a greater difference for distant than for near vision. Whether the right or the left eye is dominant does not seem to be a factor. The difference was greater in the eyes with poor coordination.

2. In testing the duction power of the eye, does ocular dominance influence the procedure? Should duction be tested with the rotary prism

before the nondominant eye only, or will the results be the same if it is placed before either eye?

Schoen and Scofield,²⁰ from their work on relative neuromuscular efficiency of the dominant and the nondominant eye, concluded that the threshold for diplopia—the extent to which the eye may overcome prismatic stress before binocular single vision is disrupted—is greater for the nondominant than for the dominant eye. They found that the difference is small, barely larger than the unit used, but that it is consistent. The duration of postduction diplopia—the time required for each eye to establish single binocular vision after its disruption by the removal of a surmounted prism—is significantly less for the nondominant than for the dominant eye. They expressed the belief that it is conceivable that prismatic interference of the habitually fixating, or dominant, eye produces a lower efficiency of the whole binocular mechanism than when the nondominant eye is subjected to such interference. Hence, a greater neuromuscular efficiency of the nondominant eye is manifested. If, as observation suggests, the readjusting movement of the nondominant eye follows the fixating act of the dominant eye, the practice of the latter in habitually doing this may account for the difference in the speed of readjustment.

According to the analysis of the cases here reported, the following facts were noted: When adduction was measured, a difference of 2 degrees or more was found in 34 cases when the prism was shifted from the dominant to the nondominant eye, the amount of imbalance being in most cases greater than 2 degrees. This difference was found in 25 cases when the prism was over the left eye, and in 9 when the prism was over the right eye. The right eye was dominant in 20 of the group of 25 cases, whereas it was dominant in 8 of the group of 9 cases.

In an analysis of the abduction, a difference of 2 degrees or more was found in 12 cases when the prism was shifted from the dominant to the nondominant eye. The amount of imbalance was not always greater. This difference was found in 7 cases when the prism was over the left eye, and in 4 of these the right eye was dominant; in the remaining 5 cases the difference was noted when the prism was over the right eye, and in all of these the right eye was dominant.

These results suggest that the reading obtained with the rotary prism before one eye may differ from that obtained when it is placed before the other eye. Although the difference is noted in a small percentage of cases, it is present and must be considered.

3. What is the relationship between the degree of dominancy and the coordination or binocular unity of the eyes?

In this series of cases in which the degree of binocular coordination was high, the degree of dominancy was also high.

4. Does the dominancy of the eye have any influence on the placing of prismatic corrections before the eyes?

In the matter of prismatic corrections, Mills¹⁰ stated that prisms are most comfortably worn when placed over the subordinate eye. When a high power prism is necessary and is too strong to be placed over one eye, one third of the correction may be placed over the dominant eye and two thirds over the subordinate eye. Sheard¹⁹ advised that if prismatic corrections are incorporated in glasses, prisms should not be incorporated in the lens worn before the dominant, or the sighting, eye. In cases of squint in which one tries to restore binocular single vision, prisms are to be prescribed; it seems logical, according to Sheard, that they should be placed before the squinting eye.

There may be some grounds for believing that these statements are worthy of further consideration. Practical experience, however, indicates that the equal division of prismatic corrections is a procedure which has stood the test of time. Although no experimental evidence is herein tabulated, daily experience justifies this statement. It does not seem logical that an equal amount of the prism before each eye should interfere with the relation between the two eyes, at least not to the extent as would a dissociating factor like the Maddox rod. Certainly the appearance and proper balance of the weight of the glass are factors arguing for an equal division of the prism.

5. What relation does ocular dominancy have to refraction?

Mills stated that it is important to note that in cases of myopia the fixating eye usually is more myopic, and myopia appears earlier in this eye. In an analysis of 32 cases of myopia, the following fact was determined: In 19 cases it was found that the dominant eye corresponded to the eye with the greater amount of myopia, whereas in the remainder the dominant eye was the one with the least myopia.

It has been noted that in cases in which the dominant eye is the poorer of the two eyes visually the patient is more prone to ocular discomfort when the eyes are under stress.

6. What is the effect of suppressing the dominant eye by overcorrection?

Mills expressed the belief that there is great visual and nervous advantage in maintaining the existing dominance when correcting refractive errors. "Giving a mastery to the non-dominant eye," he stated, "is likely to cause anguish both to the patient and to the physician." Sheard¹⁹ reiterated Mills' warning, declaring that if anything is done to leave the visual acuity of the dominant eye lower than that of the nondominant eye, discomfort will ensue and persist. Does one create a similar situation when in the process of developing an amblyopic eye the better seeing eye is occluded? It has been noted that in carrying out this procedure some patients' reaction suggests more of an upset

than others. For example, an 8 year old child with vision of 20/20 in his left eye had this eye completely and constantly occluded. Evidence of incoordination in his speech developed, and he was in a highly nervous state. Is it possible that, as in shifting handedness, a fine coordinated balance in the higher centers is disturbed? In a stable person such a change has no appreciable effect, whereas in an unstable person the change disrupts the whole nervous mechanism.

It therefore seems logical, with the present meager knowledge of the significance of dominancy, that in correcting errors of refraction one should maintain the mastery or better visual acuity in the dominant eye.

7. Another point which may be of practical value is the consideration of the normal line of vision.

In holding reading matter before the eyes it has been found that certain persons line it up with the dominant eye. To illustrate, a 46 year old patient required bifocal lenses. He was uncomfortable when wearing them and complained that he could not see well with his left (less dominant) eye. Examination revealed that he was holding his reading matter directly in front of his right (dominant) eye and that he was looking with his left eye through the edge of the left bifocal segment. As soon as this fact was called to his attention and the reading matter shifted to the midline, he was comfortable.

In the group of cases here reported this tendency toward deviation was present in 96 cases. In 59 of these the deviation was to the right, and in 58 of these the right eye was dominant. In this group the percentage of dominancy was 75 and of binocular coordination, 92. In 37 cases deviation was to the left; in 15 of these the right eye was dominant, and the percentage of dominancy was 65 and of coordination, 91. In 22 of the cases in this group the left eye was dominant, and the percentage of dominancy was 67 and of coordination, 90. There were 29 cases in which there was no deviation; in 24 the right eye was dominant, and the percentage of dominancy was 77 and of coordination, 90. The foregoing figures indicate that dominancy and coordination do not seem to be the factor in determining whether an object is held before one eye more than the other. The figures do suggest that in a greater percentage of cases deviation is in the direction of the dominant eye.

It therefore seems necessary to check the position of reading matter in relation to the eyes. Undoubtedly in cases of mild deviation it is not significant, but in cases of marked deviation, as illustrated, it assumes importance.

8. In relation to operative work on ocular muscles, the dominant eye, according to O'Connor, plays a part.

O'Connor's technic for bringing the eyes into a parallel position involves the nonfixating eye. Although this phase of surgical work on the ocular muscles is not generally emphasized, one should be aware of it. Undoubtedly most ophthalmologists in selecting the eye for an operation on the muscles select the less dominant eye when but one is to be operated on, because it shows the squint more consistently and usually is the poorer eye visually. That all such operations should be confined to the nondominant eye seems illogical.

The question of selecting the less dominant eye for operation naturally leads to the application of this principle to operations for cataract. In cases in which both eyes are cataractous and the findings much the same, it suggests that one should operate on the dominant eye first. This dominancy could be determined by the handedness of the patient and by questioning him as to his ocular habits if a sighting test is not possible. This suggests the possibility that if but one eye is to be operated on it is possible that the patient will adjust himself to the new condition if his dominant eye is the seeing eye. This seems especially so if the right eye is dominant and the subject is right handed, because some believe the right eye directs the actions of the right hand more efficiently than the left eye.

9. The final consideration of this phase of the subject is the possibility of utilizing the test for dominancy as a test for malingering. It is recognized that only a marked loss of vision will cause a shift of dominancy. The real dominancy can be inferred frequently from the history and the sidedness. In using the Bryngelson test for dominancy, the examiner can see exactly which eye is dominant. If the defective eye happens to be the dominant eye, a certain amount of information as to the vision can be obtained without the patient's knowledge. If it is very defective, as he may claim, the dominancy will be shifted to the other eye.

In summary, it seems evident that in considering this phase of the work one is in an interesting field but also a field in which actual facts concerning dominancy are few. One must therefore accept its various angles in this light, because it would be impossible to be dogmatic. The most logical part of this phase of the work is the matter of the dissociating element. Although data are not conclusive, they do suggest that there is a difference in the amount of the hyperphoria when measured before one eye and then the other. There certainly can be no serious objection, and perhaps some logic in the light of the known facts, to placing the Maddox rod before the nondominant eye. Whether one should always place the measuring prism before this eye is perhaps not so important. It does not seem important that ductions be measured with the prism before the nondominant eye, as such a procedure is of a different nature than that involving the use

of Maddox rod. The result in this series of cases suggests some difference in the readings, but more data are necessary to substantiate it.

In the matter of incorporating a prism into the lens, it does not seem necessary to place it always before the less dominant eye. To create disadvantages, such as a heavier and a more unsightly glass on one side, is a point worth considering and one that is not offset by the questionable value of placing all of the prism before the non-dominant eye. Dominancy should not be influenced by the action of the prism, because the prism does not interfere with or impede the dominant eye as would the Maddox rod.

It seems practical to consider the alinement of reading matter. This is especially true when a bifocal correction is prescribed.

There is some evidence which points to the importance of maintaining the dominant eye as the master eye. The operative phase of this subject is but suggestive and perhaps of no practical value. The test for malingering may have some merit.

CONCLUSION

This work has but one object, namely, to stimulate interest in the subject of ocular dominancy. Whether ocular dominancy is but an interesting fact or is of definite clinical importance is as yet unknown. The apparent indifference of ophthalmologists toward the subject suggests the former. This study of the problem was undertaken in a very skeptical frame of mind, because it is believed that only with such an attitude can the results be conservatively evaluated. Many factors suggest that it is worthy of further consideration, and if this presentation serves to stimulate some interest in ocular dominancy it will have served its purpose.

ABSTRACT OF DISCUSSION

DR. DERRICK T. VAIL JR., Cincinnati: For years the term "dominant eye" has created interest and speculation. As Dr. Fink has said, most of the investigations regarding the subject have been carried out by nonmedical workers. This is the first attempt by a trained ophthalmologist to make an exhaustive study. That his patience and interest should have survived long enough for him to make this most complete and overwhelming study is a credit and testament to his scientific sense. Unfortunately, when all the evidence is evaluated, one seems to be back at the starting place.

A study of Dr. Fink's paper suggests that it is not the eye that is dominant but rather the hemisphere of the brain. After-image tests support this contention, a point not sufficiently emphasized by Dr. Fink, I think. If this were so, it would explain the combination of eyedness and handedness. In the development of the race, survival depended on fighting ability. With the shield protecting the heart and held by the left hand, the right eye was used as the sighting eye in throwing a spear with the free, or right, hand.

The usefulness of the test for ocular dominancy in malingering deserves more attention. If the dominant eye, or its determination, were important in any realm save that of sport, its clinical demands, I feel sure, would have become manifest before this.

The subject is exceedingly interesting from a speculative point of view, and ophthalmologists are indebted to Dr. Fink for his careful and thorough investigation of the subject.

Clinical Notes

A MODIFICATION OF THE IRIDENCELEISIS TECHNIC

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In performing iridencleisis I have found some difficulty in reversing the tongue of iris after the meridional incision has been made. Because of this, undue manipulation of the iris is necessitated, with an attendant loss of pigment. Since it is most important for the success of this operation to obtain a pigment-lined cicatrix in the scleral section, all possible means for preventing loss of pigment must be utilized.

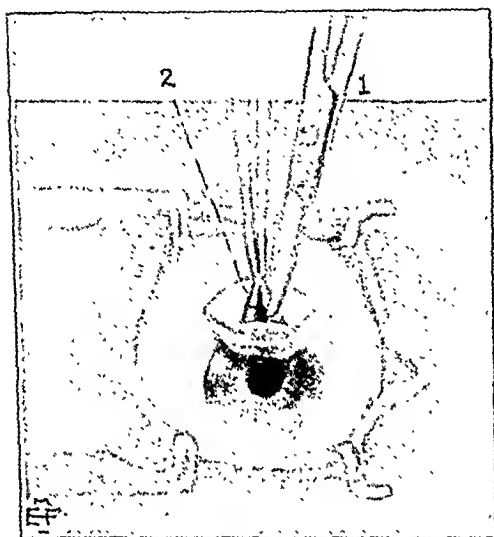


Figure 1

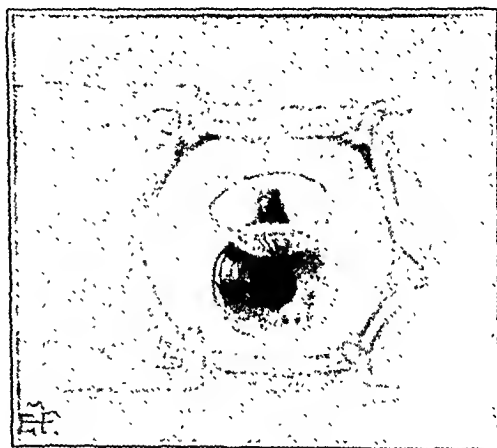


Figure 2

Fig. 1.—Drawing showing the iris pulled out of the wound and the two meridional cuts, one on either side of the forceps, from the pupillary border to the periphery, made with blunt-pointed scissors. The first cut through the iris is indicated by the dash line, and the second cut, by the line along the right side of the forceps.

Fig. 2.—Drawing showing the oblong tongue of iris placed on the sclera with the pigmented surface up.

The following procedure is a simple modification of the Holth technic, which minimizes the manipulation of the iris and conserves the epithelium: After the iris is grasped at the pupillary border and drawn out of the wound, two meridional cuts are made, one on either side of the forceps. The resulting oblong flap of iris can then easily be laid out on the sclera like an apron, pigmented surface up, with a modicum

Read before the Clinical Society of the Herman Knapp Memorial Eye Hospital, Dec. 23, 1937.

of manipulation. The advantages of this simple modification are as follows: 1. A broader base is obtained for the filtering scar. 2. The tongue of the iris is everted and placed on the sclera with ease. 3. The pigment epithelium is retained. 4. There is no tendency for the tag of the iris to retract into the anterior chamber. 5. The pillars of the iris are not drawn into the wound, and a keyhole pupil results.

KERATITIS SICCA

Report of a Case

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Lack of tears leads to dryness of the eyes and to a clinical condition variously described as keratitis sicca, keratoconjunctivitis sicca or keratitis filamentosa. The symptoms are stickiness of the lids and burning and painful sensations, often most intense on awakening. Any disease that destroys the lacrimal gland or its innervation can cause this difficulty. The most satisfactory treatment available was proposed by Beetham¹ in 1935, that is, closure of the canaliculi by electrocoagulation. I have found that after closure of the canaliculi instillation of artificial tears adds further to the comfort of the patient. Keratitis sicca is an uncommon disease, occurring usually among women after the menopause. The symptoms persist for many years; sometimes slight remissions occur. Without treatment, patients with this condition find that any use of their eyes causes discomfort.

REPORT OF CASE

A girl aged 17 years came to the clinic in April 1935 with the complaint of pain and a sensation of scratching in her eyes. The symptoms had been present for three years in the left eye and for three months in the right. Six months before the onset of these symptoms, swelling of the left side of her face occurred. It lasted about two weeks and recurred several times during the next few months. Then the left eyelids became swollen for a week. Thereafter, painful swelling recurred every few weeks, lasting from one to two weeks and involving either the right or the left side of the face or the left eyelids. On a few occasions the right and left submaxillary regions had been swollen. The patient could not recall that fever accompanied the condition; other parts of the body were not involved. Apparently, chronic infection of the lacrimal and salivary glands was present.

Examination revealed the presence of filamentary keratitis. In the lower cul-de-sac there were threads of mucus, and attached to the cornea there were a dozen or more strands of epithelium, from 2 to 6 mm. in length. Fluorescein stained the cornea in numerous discrete and confluent punctate regions. These signs and the intensity of the symptoms varied greatly from week to week. Carotene in oil instilled three times a day gave the patient partial relief during the next two years.

From the Section on Ophthalmology, The Mayo Clinic.

1. Beetham, W. P.: Filamentary Keratitis, *Tr. Am. Ophth. Soc.* **33**:413-435, 1935.

The lacrimal secretion was greatly diminished, measured according to the method of Schirmer. The secretion from the right eye moistened a strip of filter paper 5 mm. wide for a distance of 5 mm., and that from the left eye moistened a similar strip for a distance of 4 mm. The filter paper was in contact with the secretion for five minutes. The secretion from normal eyes moistened such a strip more than 10 mm. of its length in this time.

In August 1937, according to the suggestion of Beetham, the canaliculi of the left eyelids were closed by means of electrocoagulation. Although the ulcers and filaments were fewer after this procedure, enough remained to keep the patient uncomfortable. It was evident that the flow of tears was practically nonexistent, so that even after the canaliculi were closed there were not enough tears to keep the eye moist. The patient was then told to instil into the left eye, three times a day, a solution resembling tears in composition; this mixture consisted of Locke's solution to which was added enough of the patient's blood serum to make a 10 per cent solution of her serum. After instillation of these substitute tears, within forty-eight hours all ulcers and filaments had disappeared, and the patient was comfortable. The next month the canaliculi of the right eyelids were closed by means of electrocoagulation. The following day no filaments and only a few punctate ulcers were present. Apparently, on the right side there was almost enough lacrimal secretion to keep the eye moist when the drainage of tears was blocked. Even after closure of all four canaliculi the patient complained that her eyes felt sticky and painful on awakening in the morning. Instillation of the artificial tears gave quick relief. Use of the drops three times a day in the left eye and twice a day in the right has kept her entirely comfortable.

Ophthalmologic Review

EDITED BY DR. FRANCIS HEED ADLER

TREATMENT OF CONJUNCTIVITIS

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NEW YORK

In this review an attempt will be made to summarize the methods of treatment which are in general use or have been advocated for the more common forms of conjunctivitis.

It is difficult to evaluate these methods, owing to the dearth of well controlled clinical researches on conjunctivitis and the impossibility of estimating with any degree of accuracy the value of therapeutic procedures as tested in ordinary practice in the office or in the clinic. Opinion concerning the treatment of acute and subacute catarrhal conjunctivitis, which are characteristically self limited, must inevitably be questioned; only with chronic conjunctivitis, which shows no tendency to spontaneous cure, or in special types of conjunctivitis the clinical course of which can be predicted may therapeutic efficacy safely be estimated. In view of the manifest difficulties inherent in therapeutic research on the conjunctiva, it is felt that all reports should be examined critically.

PRODUCTION OF CONJUNCTIVAL INFLAMMATION BY BACTERIA AND OTHER AGENTS

An understanding of the underlying mechanism by which bacteria and other agents induce conjunctivitis is essential to an evaluation of therapeutic measures.

Bacteria.—It is believed that bacteria have no mechanical action on the conjunctiva and that their action is entirely chemical, arising from the liberation of soluble toxic products. Pathogenic bacteria may be disease producing while proliferating as follows: (1) superficially, (2) on living epithelial cells or (3) beneath the epithelium.

Bacteria proliferating superficially in the mucous film on the surface of the conjunctiva or on desquamated epithelial cells (e. g., in conjunctivitis due to the Morax-Axenfeld bacillus) liberate toxins (exo-

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toxins and endotoxins) which are believed to diffuse through the epithelium, damaging the cells and producing inflammation. The leukocytic response varies according to the chemotactic effect of the particular toxin concerned. The toxins of *Staphylococcus aureus*, for example, generally produce a marked neutrophilic response, while the toxins of *Haemophilus lacunatus* (Morax-Axenfeld) and of *Neisseria catarrhalis* produce little or no response. The type and degree of the toxic stimulus also determine the degree of cellular infiltration of the conjunctiva and the type of hypertrophy, whether follicular or papillary.

Bacteria proliferating on living epithelial cells (e. g., in conjunctivitis due to the Koch-Weeks bacillus) have been shown by Lindner¹ and by Howard² to attach themselves to living cells as soon as they enter the conjunctival sac and to form, by multiplication, a turflike growth in a single layer, each organism being attached to the cell. The infection spreads as the bacteria detach themselves from the original foci to produce new ones. Eventually, in a severe infection, the entire conjunctiva, both palpebral and bulbar, becomes involved. The exotoxins of the bacteria bring about a dissolution of intercellular cement substance, which enables the organisms to penetrate into the deeper layers of the epithelium.

Bacteria proliferating beneath the epithelium (e. g., in gonorrheal endogenous conjunctivitis) reach the subepithelial layers of the conjunctiva generally by way of the blood stream. Occasionally, however, an exogenous infection may occur: Tuberculous conjunctivitis in some cases appears to be a primary exogenous infection, and Verhoeff³ expressed the belief that the leptothrix which he has described as the cause of Parinaud's conjunctivitis reaches the subepithelial tissues through the epithelium.

Viruses.—It is believed that viruses liberate toxins much as bacteria do, although there are as yet no well established data available. It is probable that they multiply only within living cells, some only in the epithelium (e. g., the virus of trachoma and of inclusion conjunctivitis) and others in other tissues as well (e. g., the virus of herpes simplex and of herpes zoster).

1. Lindner, K.: Ueber die Topographie der Bindehautkeime, *Ztschr. f. Augenh.* **42**:11, 1919; Ueber die Topographie der parasitären Bindehautkeime, *Arch. f. Ophth.* **105**:726, 1921.

2. Howard, H. J.: Rôle of the Epithelial Cell in Conjunctival and Corneal Infections, *Tr. Am. Ophth. Soc.* **22**:186, 1924.

3. Verhoeff, F. H.: Parinaud's Conjunctivitis: A Mycotic Disease Due to a Hitherto Undescribed Filamentous Organism, *Arch. Ophth.* **43**:145, 1913. Verhoeff, F. H., and King, M. J.: Leptotrichosis Conjunctivae (Parinaud's Conjunctivitis), *ibid.* **9**:701 (May) 1933.

Allergy.—Allergic conjunctivitis is believed to be the result of injury to the cells of the conjunctiva by an antigen-antibody reaction occurring on or in those cells by which antibody has been fixed.⁴

DEFENSIVE REACTIONS OF THE CONJUNCTIVA

Therapy should work in harmony with the natural defenses of the conjunctiva whenever possible. These defenses have been considered in some detail by Howard⁵ and may be summarized as follows:

Defenses of the Normal Conjunctiva.—Lysozyme: Fleming⁶ in 1922 showed that tears contain a ferment, which he called lysozyme, capable of dissolving many strains of bacteria, particularly those derived from the air. It is believed that this enzyme plays an important role in maintaining the relatively bacteria-free condition of the normal conjunctiva. What effect it may have on pathogenic bacteria is not yet known.

Phagocytosis: Under normal conditions the polymorphonuclear leukocytes probably play a role in the destruction of bacteria. They can usually be demonstrated in small numbers on the normal conjunctiva in epithelial scrapings.

Preformed Antibodies: Antibodies formed as a result of previous exposure to bacteria or their products probably play a protective role in certain cases by neutralizing bacterial toxins or by stimulating phagocytosis by leukocytes (opsonins); e. g., the immunity of the conjunctivas of most persons to *Corynebacterium diphtheriae* is due to circulating diphtheria antitoxin previously formed as a result of natural or artificial contact with diphtheria toxin.

Defenses of the Diseased Conjunctiva.—*Mechanical Defenses:* *Lacrimation.* The continuous irrigation of the conjunctival sac probably tends to wash away bacteria and to make it difficult for them to gain a foothold on the conjunctiva. In the presence of inflammation the flow of tears is increased and tends to remove all loose bacteria by passage into the nose.

Exfoliation of epithelial cells. Bacterial toxins effect dissolution of intercellular cement substance, cellular edema and increased proliferation of the basal layers, processes which in turn accelerate the normal desquamation of cells. When bacteria proliferate on the cells, this dequamation probably contributes to their removal.

4. Topley, W. W., and Wilson, G. S.: *Principles of Bacteriology and Immunity*, Baltimore, William Wood & Company, 1936, p. 897.

5. Howard, H. J.: *Offensive and Defensive Factors in Mechanism of Acute Infections of Mucous Membranes*, J. Kansas M. Soc. **33**:236, 1932.

6. Fleming, A.: *On a Remarkable Bacteriolytic Element Found in Tissues and Secretions*, Proc. Roy. Soc., London, s.B **93**:306, 1922.

Hyperemia and edema. With the development of conjunctival inflammation there occurs an oozing of serum and cells, which forms a current against which the bacteria must grow to penetrate the epithelium. Numerous bacteria are carried by this current into the conjunctival sac.

Biologic Defenses: Resistance of repaired tissues. Howard⁵ expressed the belief that destroyed epithelium is replaced by new epithelium, which is more resistant than the old.

Phagocytosis by epithelial cells. Lindner¹ and Howard² called attention to the fact that in certain acute infections, such as gonorrheal ophthalmia and Koch-Weeks conjunctivitis, the conjunctival epithelial cells phagocytose and digest the bacteria; they expressed the belief that this behavior constitutes a major conjunctival defense.

Immunologic Defenses: Antibodies. It is doubtful if the development of antibodies plays any role in the natural healing of catarrhal conjunctivitis. Bacteria located either on the surface or in the epithelium are, immunologically speaking, outside the body and do not detectably stimulate the formation of immune bodies. Thus it has been found⁷ impossible experimentally to immunize rabbits by instillation of staphylococcus exotoxin into the conjunctival sac, although immunization by intracutaneous injection has been successful. Bacteria located subepithelially, however, may immunize; e. g., agglutinins for *Pasteurella tularensis* usually develop in cases of tularemia of the oculoglandular type within a week.

Specific local immunity. No evidence has been advanced to indicate that the conjunctiva is capable of developing a specific immunity not shared by the body as a whole.

Nonspecific local immunity. The development of a resistance due to the mobilization of tissue histiocytes⁸ is well known. It is nonspecific.

ROLE OF THE LABORATORY IN THE MANAGEMENT OF CONJUNCTIVITIS

The value of an etiologic diagnosis in treating such special diseases as diphtheritic and gonorrheal conjunctivitis is readily apparent. It is less so in cases of acute and subacute conjunctivitis, which are self limited, but again in cases of chronic conjunctivitis determination of the etiology may be of real value in the selection of therapeutic measures; when knowledge of the cause is valueless therapeutically, as in cases of inclusion blennorrhea, it may serve prognostically.

7. Thygeson, P.: Bacterial Factors in Chronic Catarrhal Conjunctivitis, *Arch. Ophth.* 18:373 (Sept.) 1937.

8. Topley and Wilson,⁴ p. 931.

TABLE 1.—*Laboratory Findings in the Principal Types of Conjunctivitis*

Type of Conjunctivitis	Culture	Secretion Smears	Epithelial Scrapings
Hyperacute conjunctivitis	N. gonorrhoeae; rarely N. meningitidis (aseptic fluid-blood agar)	Positive	Positive
Acute and subacute conjunctivitis	Probable causal bacteria: D. pneumoniae, H. influenzae, H. conjunctivitis (Koch-Weeks), Staph. aureus, Str. haemolyticus and others	Positive	Often positive
Chronic catarrhal conjunctivitis	Probable causal bacteria; principally Staph. aureus and H. lacunatus (Morax-Axenfeld)	Often negative	Usually positive
Lacrimal conjunctivitis	Causal bacteria: D. pneumoniae, H. influenzae and others	Usually positive	Usually negative
Trachoma	Negative in cases without complications; positive in cases of secondary infection	Negative	Prowazek-Halberstädt inclusion bodies in the early stages and in cases of severe involvement
Inclusion conjunctivitis	Negative	.....	Inclusion bodies in cases in the early stage
Acute follicular conjunctivitis (Béal)	Negative	Mononuclear cellular exudate	Mononuclear cellular exudate
Chronic follicular conjunctivitis	Negative	Negative	Negative
Folliculosis	Negative	Negative	Negative
Prexerosis	.....	.....	Keratinized epithellum and B. xerosis in bulbar scrapings
Pseudomembranous conjunctivitis	C. diphtheriae or Str. haemolyticus; rarely others	.....	.....
Ocular pemphigus	.....	.....	Eosinophilia commonly present
Vernal catarrh	.....	.....	Eosinophilia
Allergic conjunctivitis	.....	.....	Eosinophilia
Keratooconjunctivitis due to rosacea	Staph. aureus often found	.....	.....
Phlyctenular keratoconjunctivitis	Staph. aureus or H. lacunatus (Morax-Axenfeld) often found	.....	.....
Parinaud's conjunctivitis	Leptothrix (Verhoeff) demonstrated on biopsy by special stain and culture	.....
Oculoglandular type of tularemia	Agglutination test for Past. tularensis positive usually after first week		
Molluscum conjunctivitis	Elementary bodies demonstrated by Löffler's flagella stain of expressed core of molluscum nodule		
Tuberculous conjunctivitis	Tubercle bacilli usually demonstrated in scrapings from ulcers; guinea-pig inoculated with material obtained at biopsy		

The etiology can often be inferred from specific conjunctival changes and occasionally in cases of catarrhal conjunctivitis by a knowledge of the types of conjunctivitis prevailing in the region. Under ordinary circumstances, however, laboratory examination is indicated as follows:

(a) In cases of pseudomembranous conjunctivitis, to distinguish between diphtheritic, streptococcic and other infections.

(b) In cases of hyperacute conjunctivitis, for the diagnosis of gonococcic infection.

(c) In cases of acute follicular conjunctivitis, to distinguish between the Béal type and that due to the inclusion virus.

(d) In all cases of ophthalmia neonatorum, to differentiate gonorrheal conjunctivitis from inclusion blennorrhea and nongonorrheal bacterial infections.

(e) In cases of trachoma, to determine the presence or absence of secondary bacterial infection.

(f) In cases of chronic catarrhal conjunctivitis, to determine whether the infection is due to *Staph. aureus* or to the Morax-Axenfeld bacillus.

(g) In cases of chronic conjunctivitis associated with itching, for the determination of eosinophilia as an indication of allergy.

(h) In cases of vernal catarrh, to confirm the clinical diagnosis by demonstrating eosinophilia.

The ophthalmologist should interpret his laboratory findings with considerable caution, keeping the clinical picture in mind at all times. The occurrence of a particular bacterium does not necessarily mean that it is the cause of the conjunctivitis. When such organisms as *C. diphtheriae*, *Neisseria gonorrhoeae*, *Neisseria meningitidis* and *Haemophilus conjunctivitis* (Koch-Weeks) are found they may be considered etiologic forthwith, but the relation of such facultative organisms as *Staph. aureus*, *Escherichia coli* and *Diplococcus pneumoniae* must be questioned in the light of the clinical disease. Pathogenicity may be assumed for *D. pneumoniae*, for example, if it is found in cases of acute catarrhal conjunctivitis, or for *Staph. aureus* if it is found in cases of chronic blepharoconjunctivitis. That the bacteria may be playing a secondary role must always be borne in mind; any of the bacteria producing catarrhal conjunctivitis may secondarily infect trachoma and other specific diseases.

The important laboratory findings for the principal types of conjunctivitis are summarized in table 1.

A CONSIDERATION OF THERAPEUTIC AGENTS

Bactericidal and Bacteriostatic Agents.—In considering antiseptics for use on the conjunctiva, the following points should be kept in mind:

1. Bactericidal activity in the presence of organic matter (serum and cells)
2. Irritative action
3. Effect of dilution
4. Effect of hydrogen ion concentration
5. Nonspecific actions
 - (a) Desquamation of epithelium
 - (b) Stimulation of phagocytic activity of epithelial cells
 - (c) Chemotactic effect on leukocytes
 - (d) Effect on lysozyme
6. Type of infection in which the agent is to be employed

Numerous studies have been made on the germicidal power of various antiseptics in vitro, but there is unfortunately almost no information available regarding their action in cases of conjunctivitis. At the time of writing there appears to be no one antiseptic with outstanding advantages. The one most commonly used, silver nitrate, probably

depends for much of its efficacy on nonspecific activity, in particular on its desquamative action, which would appear to make it especially valuable in the treatment of those types of conjunctivitis in which the bacteria invade the epithelium (e. g., gonorrheal ophthalmia and Koch-Weeks conjunctivitis). It is doubtful, however, if any antiseptic used locally contributes materially to the sterilization of the conjunctiva when the bacteria are actually in or beneath the epithelium. Antiseptics are probably most useful in the treatment of those conjunctival inflammations in which the bacteria proliferate in the mucous film on the surface of the conjunctiva, as is the case in conjunctivitis due to the staphylococcus or to the Morax-Axenfeld bacillus. But even if the bacteria are superficial and are destroyed by the antiseptic, a reservoir of organisms may remain in the lacrimal sac, on the margins of the lid or in the meibomian glands, and reinfection of the conjunctiva may readily take place. In cases of papillary hypertrophy, too, the bacteria, although not in the epithelium, may be harbored in the clefts and pseudoglands which are formed.

The value of irrigations in the treatment of conjunctivitis has not been sufficiently investigated, but since the efficiency of antiseptics is definitely reduced by organic material, irrigation prior to the use of the antiseptic would seem to be indicated. The efficiency of the antiseptic may also be reduced if it fails to cover the entire conjunctiva when applied. This will frequently be the case if the antiseptic is instilled into the conjunctival sac, usually the lower fornix, or if applied only to the palpebral conjunctiva. An irritating antiseptic is rapidly diluted by tears.

In some respects ointments are superior to aqueous solutions: They remain in the conjunctival sac longer, they can be used in higher concentrations and they resist dilution. Their interference with drainage, on the other hand, is believed by some ophthalmologists to render them undesirable.

The ideal conjunctival antiseptic has not yet been discovered. It is generally recognized that the phenol coefficient is not a reliable guide to therapeutic usefulness on mucous membranes, and consequently there have been some attempts to rate antiseptics for toxicity to tissues as well as for their ability to kill bacteria. It is of distinct interest that in three recent studies (Salle, McOmie and Shechmeister,⁹ Nye¹⁰ and Thompson, Isaacs and Khorazo¹¹) iodine in aqueous solution has been

9. Salle, A. J.; McOmie, W. A., and Shechmeister, I. L.: New Method for the Evaluation of Germicidal Substances, *J. Bact.* **34**:267, 1937.

10. Nye, R. N.: Relative in Vitro Activity of Certain Antiseptics in Aqueous Solution, *J. A. M. A.* **108**:280 (Jan. 23) 1937.

11. Thompson, R.; Isaacs, M. L., and Khorazo, D.: Laboratory Study of Some Antiseptics with Reference to Ocular Application, *Am. J. Ophth.* **20**:1087, 1937.

found to be relatively nonirritating to tissues and at the same time decidedly superior to the commonly employed organic preparations in ability to kill *Staph. aureus*. It has as yet not received clinical trial in cases of conjunctivitis.

Two chemotherapeutic agents have been advanced for specific use on the conjunctiva: ethylhydrocupreine hydrochloride, specific for the pneumococcus, and zinc sulfate (or chloride), specific for the Morax-Axenfeld bacillus. Ethylhydrocupreine is not in general use for the reasons that pneumococcic infections of the conjunctiva are generally self-limited and that other nonspecific antiseptics apparently shorten the course of the disease quite as effectively. Zinc sulfate has come into general use in the treatment of chronic conjunctivitis for the sake of its astringent properties, although in many parts of the United States, at least, the Morax-Axenfeld bacillus is only rarely found.

A new drug, sulfanilamide (and its dye derivatives which are known as prontosil), has been advanced for use in the treatment of infections due to the beta hemolytic streptococcus. Early reports,¹² both clinical and experimental, have been favorable, but so far there have been no reports on the efficacy of this drug in the treatment of conjunctivitis, owing no doubt to the fact that infections of the conjunctiva due to hemolytic streptococci are rare. There is also clinical evidence¹³ that the drug is active against certain other bacteria, particularly the gonococcus and the meningococcus. Gonorrhea which has previously been resistant to therapy has been reported as responding well to a combination of sulfanilamide and fever therapy.¹⁴ The preparation is not entirely harmless, however, and a number of complications, including agranulocytosis, allergic reactions, cyanosis, pyrexia, jaundice, and purpuric and scarlatiniform eruptions, have occurred.

Nonspecific Protein and Fever Therapy.—Foreign protein therapy has come into general use as a valuable therapeutic agent in ophthal-

12. Domagk, G.: Ein Betrag zur Chemotherapie der bakteriellen Infektionen, *Deutsche med. Wchnschr.* **61**:250, 1935. Tréfouël, J.: Tréfouël, J. (Mme.); Nitti, F., and Bovet, D.: Activité du p-aminophénylsulfamide sur les infections streptococciques expérimentales de la souris et du lapin, *Compt. rend Soc. de biol.* **120**:756, 1935. Levaditi, C., and Vaisman, A.: L'action préventive du chlorhydrate de 4'sulfamido-2.4-diaminoazobenzene dans l'infection streptococcique expérimentale de la souris, *ibid.* **121**:803, 1936. Colebrook, L., and Kenny, M.: Treatment of Human Puerperal Infections, and of Experimental Infections in Mice, with Prontosil, *Lancet* **1**:1279, 1936. Buttle, G. A. H.; Gray, W. H., and Stephenson, D.: Protection of Mice Against Streptococcal and Other Infections by *p*-Aminobenzenesulphonamide and Related Substances, *ibid.* **1**:1286, 1936.

13. Dees, J. E., and Colston, J. A. C.: Use of Sulfanilamide in Gonococcic Infections: Preliminary Report, *J. A. M. A.* **108**:1855 (May 29) 1937.

14. Ballenger, E. G.; Elder, O. F., and McDonald, H. P.: Sulfanilamide and Thermo-therapy in Gonococcic Infections, *J. A. M. A.* **109**:1037 (Sept. 25) 1937.

mology. The mechanism of action is not entirely clear, and the actual cause of the beneficial effects which undeniably follow its use has not been established. The following actions have been described:¹⁵ fever, leukocytosis, mobilization of preformed antibodies, increase in the bactericidal power of the blood, general stimulation of the metabolism of all cells, increase in the permeability of the capillaries and increase in the activity of the reticulo-endothelial system.

This type of therapy is established on a firm experimental basis: Animals have shown increased resistance to infection after injections of nonspecific protein, withstanding as much as ten times the normally lethal doses. It appears, furthermore, to be peculiarly adapted to the eye, since ocular infections do not seem to stimulate body defenses as a whole. The fact that it is particularly effective against notoriously heat-sensitive bacteria, such as the gonococcus, would seem to indicate that the production of fever is a major action.

Typhoid vaccine and milk are the proteins most generally employed, although others, such as omnadin (a nonspecific substance containing albumin, lipoid and fat), antidipltheritic serum and autoserum, have been used. Typhoid vaccine given intravenously has the following advantages: (1) absence of local reaction, (2) ease of administration and (3) relative uniformity of dosage. It is to be recommended for all patients except infants, to whom milk should be given intramuscularly.

Fever induced by electrical means or by heat cabinets has been employed with success in the treatment of syphilis and gonorrhea and should have increasing application in ocular conditions. By these means any desired temperature can be produced and maintained. The mechanism of action seems to be essentially like that of foreign protein.

Immunologic Agents and Procedures.—Vaccine Therapy: This form of therapy is limited theoretically to those conditions in which the existing infection is not providing a satisfactory stimulus to the immunity-building apparatus of the body, i. e., to most infections of the eye. Theoretically, vaccines should be effective against those bacteria which act principally by endotoxins, and autogenous vaccines should be preferable to stock preparations. In practice, however, the usefulness of specific vaccine therapy is limited to staphylococcic infections, and autogenous vaccines have small advantage over stock vaccines. Moreover, it now seems probable that staphylococcus toxoid¹⁶ will supersede the vaccine.

15. Petersen, W. F.: *Protein Therapy and Nonspecific Resistance*, New York, The Macmillan Company, 1922.

16. Dolman, C. E., and Kitching, J. S.: Tests for Innocuity and Antigenic Potency of Staphylococcus Toxoid, *J. Path. & Bact.* **41**:137, 1935. Dolman, C. E.: Treatment of Localized Staphylococcic Infections with Staphylococcus Toxoid, *J. A. M. A.* **100**:1007 (April 1) 1933; Clinical Uses of Staphylococcus Toxoid, *Lancet* **1**:306, 1935.

Toxins and Toxoids: These therapeutic products are used to produce an active antitoxic immunity against bacteria which act principally by exotoxins. Staphylococcus toxin has been employed with success by Burky¹⁷ in the treatment of local staphylococcic infections of the eye, but toxoid (toxin detoxified by formaldehyde) would seem to be preferable in view of its greater safety and availability. Diphtheria toxoid probably acts prophylactically in preventing diphtheritic conjunctivitis, but it is of no value in treatment. Diphtheritic conjunctivitis is an acute infection and runs its course before an active immunity can be built up.

Antitoxins: This form of therapy is used to produce a passive antitoxic immunity. Diphtheria antitoxin is effective in the cure of conjunctivitis due to *C. diphtheriae* except in the rare cases in which the infection is mixed with a streptococcic infection. Antimeningococcus antitoxin (Ferry¹⁸) has recently been shown to be of value in the treatment of meningococcic infections, and Kluever¹⁹ has reported favorable, though not curative, results with scarlet fever antitoxin in a case of pseudomembranous conjunctivitis caused by hemolytic streptococci.

Antibacterial Serums: These serums have been used with limited success to produce passive immunity against bacteria which act principally by endotoxins. An immune serum has been employed in the treatment of tularemia by Kudo²⁰ and by Foshay.²¹

Tuberculin: The use of tuberculin in the treatment of phlyctenular conjunctivitis and conjunctival tuberculosis has met with questionable success. According to Woods,²² tuberculin should be used to achieve and maintain tissue desensitization rather than to produce focal reactions.

Desensitization: This form of therapy can be tried in cases of allergic conjunctivitis in which the causal agent is known but cannot be removed from the environment. This has been done in cases of hay fever conjunctivitis with some success and by Waller²³ in cases of sensitivity to atropine.

17. Burky, E. L.: Studies on the Action of Staphylococcus Toxin and Antitoxin with Special Reference to Ophthalmology, *Am. J. Ophth.* **19**:841, 1936.

18. Ferry, N. S.: Meningococcus Antitoxin, *J. Immunol.* **23**:315, 1932. Hoyne, A. L.: Treatment of Meningococcic Infections, *Arch. Pediat.* **53**:164, 1936.

19. Kluever, H. C.: Streptococcal Pseudomembranous Conjunctivitis, *Am. J. Ophth.* **18**:1094, 1935.

20. Kudo, M.: Studien über das Bakteriumtularense, *Jap. J. Exper. Med.* **12**:377, 1934.

21. Foshay, L.: Tularemia Treated by a New Specific Antiserum, *Am. J. M. Sc.* **187**:235, 1934.

22. Woods, A. C.: Treatment of Ocular Tuberculosis, *Tr. Am. Ophth. Soc.*, 1937, to be published.

23. Waller, R. G.: Atropine Irritation and Its Prevention, *Tr. Ophth. Soc. U. Kingdom* **54**:96, 1934.

Physical Therapy.—Heat: The application of heat produces an active hyperemia with increased resistance to infection but is of little value in the treatment of conjunctivitis. Heat should not be employed locally in cases of gonorrheal ophthalmia unless maintained in sufficient degree to be bactericidal; as ordinarily employed, it increases the temperature of the conjunctiva just enough to favor the growth of the gonococcus.

Cold: The application of cold produces constriction of the small vessels and is useful in lessening the swelling in the early stages of conjunctival inflammations. It is employed in the early stages of gonorrheal ophthalmia and after expression operations in cases of trachoma. Brown²⁴ cautioned against the direct use of ice, applied even through closed eyelids, because of its damaging effect on the cornea; McKee²⁵ recommended the use of pads chilled on a block of ice and frequently changed.

Ultraviolet Rays: Phototherapy has been employed in cases of chronic conjunctivitis and blepharitis, but its greatest value appears to be (1) in cases of tuberculous conjunctivitis (many cures with the Finsen lamp have been reported²⁶) and (2) in cases of phlyctenular conjunctivitis, in which general rather than local phototherapy is employed. Laws²⁷ has employed ultraviolet rays to rid the conjunctiva of bacteria preoperatively.

A consideration of the mechanism of the action of the ultraviolet rays may be found in the recent handbook by Gifford²⁸ and in the article by Brown²⁴ in Berens' "The Eye and Its Diseases." The ultraviolet rays are known to be bactericidal in effect, to stimulate the formation of vitamin D in the body, to increase the bactericidal power of the blood and to produce a local hyperemia. They must be employed with some caution to avoid the possibility of damage to the cornea and lens.

Radium and X-Ray: Radium has been employed with some success in the treatment of severe vernal catarrh, but the occurrence of late

24. Brown, A. L., in Berens, C.: *The Eye and Its Diseases*, Philadelphia, W. B. Saunders Company, 1936, p. 1014.

25. McKee, S. H., in Berens, C.: *The Eye and Its Diseases*, Philadelphia, W. B. Saunders Company, 1936, p. 384.

26. François, J.: *Etude sur la conjonctivite tuberculeuse du type folliculaire*, Bull. Soc. belge d'opht., 1934, no. 68, p. 46. Blegvad, O.: *Demonstration af patienter med tuberculosis conjunctivae*, Hospitilstid. **78**:63, 1935. Neame, H.: *Conjunctival Tuberculosis with Report of Unusual Case*, Tr. Ophth. Soc. U. Kingdom **54**:76, 1934. Wittels, L.: *Klin. Oczna* **12**:486, 1934.

27. Laws, F. W.: *Present Status of Ultra-Violet Light Therapy in Eye Disease*, Tr. Ophth. Soc. U. Kingdom **53**:201, 1933.

28. Gifford, S. R.: *Ocular Therapeutics*, ed. 2, Philadelphia, Lea & Febiger, 1937, p. 103.

changes in the lens, presumably due to the radium, has led some ophthalmologists to abandon its use. Roentgen rays have been recommended by Gifford²⁹ for the treatment of intractable chronic conjunctivitis, blepharitis and dermatitis of the lids. A description of the biologic actions of radiotherapy is to be found in the recent article by Desjardins.³⁰ According to him, many forms of acute inflammation yield rapidly to a single small dose of roentgen rays. The dose must never exceed 80 per cent of an erythema dose; otherwise conjunctivitis or late degeneration of the crystalline lens may follow. This is especially likely to occur in children.

Massage: In cases of chronic conjunctivitis with infection of or overactivity of the meibomian glands massage is often helpful. The accumulated material in the ducts is expressed by massage of the lids accomplished by pressing with the two thumb nails on the cutaneous side of the two lids, which are held together and away from the globe. It is probable that the benefit derived from chaulmoogra oil in cases of trachoma is due in large part to the brisk massage employed in administering it.

Astringents.—Astringents have been employed in cases of chronic conjunctivitis, particularly in those of unknown etiology. Silver, zinc and copper salts have been found most useful, but alum and tannic acid have also been employed. Silver nitrate and copper sulfate when used in desquamating doses usually give symptomatic relief. The mechanism of action is not well understood but is associated with the removal of superficial epithelial cells.

Vasoconstrictors.—Preparations such as epinephrine hydrochloride (1:1,000) and a 3 per cent solution of ephedrine cause blanching of the superficial conjunctival vessels. They are useful in cases of vernal catarrh and of allergic conjunctivitis and are sometimes employed, mixed with mild astringents, such as a 0.25 per cent solution of zinc sulfate, in cases of chronic conjunctivitis. Their effect is entirely symptomatic.

THERAPY

Hyperacute Conjunctivitis.—The principal object of therapy for gonorrheal conjunctivitis is to maintain an intact cornea during the course of the disease. It is of prime importance to avoid trauma to the epithelium of the cornea, as ulceration usually results; competent nursing is therefore essential. Reliance must be placed on foreign

29. Gifford, S. R.: *Ocular Therapeutics*, ed. 1, Philadelphia, Lea & Febiger, 1932.

30. Desjardins, A. U.: *Radiotherapy (Roentgen Rays; Radium)*, J. A. M. A. 105:2064 (Dec. 21) 1935.

protein or fever therapy and irrigations; local antiseptics are of minor importance, since the gonococci rapidly invade the epithelium and become inaccessible.

Fever is conveniently induced by intravenous injections of typhoid vaccine, 30,000,000 bacilli being the usual dose required to produce a temperature of from 102 to 105 F. in the adult. This dose is doubled on succeeding injections, which may be given every day or every other day over a period of a week or ten days. Injections of milk should be used for infants, 1 cc. of boiled whole milk being given intragluteally at first, with an increase in the dose on subsequent injections to produce the required reaction.

Artificial fever induced by short wave diathermy or other electrical means or by the air-conditioned cabinet has been successful in the treatment of gonorrheal urethritis and of gonorrheal arthritis³¹ and will no doubt be applied generally in cases of gonorrheal conjunctivitis³² in the larger institutions. A high temperature is maintained over a sufficiently long time for the fever to be gonococcidal.

Irrigations of boric acid solution or physiologic solution of sodium chloride should be used as frequently as necessary to remove secretion and with care to prevent corneal abrasions. Mild antiseptics may be instilled. Cold compresses may be employed in the early stages if swelling is extreme; the use of hot compresses is not recommended. Gifford³³ recommended the use of conjunctival flaps when large ulcers develop.

In cases of unilateral conjunctivitis the unaffected eye should be protected by means of a Buller shield or a similar apparatus.

The return of the conjunctiva to normal after disappearance of the gonococci can probably be hastened by the use of an astringent, such as zinc sulfate or copper sulfate.

Gonococcus filtrate (Corbus-Ferry) has been employed with some success in cases of chronic gonorrhea. Although a favorable result has been reported by Storts³⁴ in a single case of ophthalmia neonatorum, it seems improbable on theoretical grounds that the filtrate will prove of value in the treatment of this disease.

Endogenous gonorrheal conjunctivitis is not uncommon and occurs in persons who have systemic gonorrhea. It is usually benign and responds well to fever therapy. It is of great importance to recognize

31. Owens, C. A.: Value of Fever Therapy for Gonorrhea, *J. A. M. A.* **107**:1942 (Dec. 12) 1936.

32. Pinkerton, F. J.: Hyperthermic Treatment for Acute Gonorrheal Ophthalmia, *Am. J. Ophth.* **20**:63, 1937.

33. Gifford,²⁸ p. 171.

34. Storts, B. P.: Ophthalmia Neonatorum Treated with Gonococcus Filtrate (Corbus-Ferry), *Arch. Pediat.* **52**:567, 1935.

and treat the iritis which usually accompanies it. Sulfanilamide should receive clinical trial for both forms of gonorrheal conjunctivitis.

The meningococcus has recently been recognized³⁵ as an occasional cause of severe conjunctivitis; it is possible that in the past meningococcic conjunctivitis has been confused with gonorrhea in some cases. No specific treatment has as yet been formulated, but the antibacterial or antitoxic serums which have proved of value in cases of meningococcic meningitis should be tried; the effect of fever therapy has not yet been determined. In other respects the disease should be treated like gonorrheal conjunctivitis.

Acute and Subacute Catarrhal Conjunctivitis.—In most cases of acute and subacute catarrhal conjunctivitis healing occurs spontaneously, but antiseptic treatment can probably shorten the course (questioned by Howard³⁶). Silver nitrate has withstood the test of time and deserves first place in the list of antiseptics. The solution in 1 or 2 per cent concentration may be applied to the everted lids, followed by irrigation with physiologic solution of sodium chloride. Mild antiseptic collyria may be prescribed for use at home. Silver nitrate ointment (0.5 per cent) has been used with success in O'Brien's clinic at the University of Iowa, and in my opinion is to be preferred to the aqueous solution, since it reaches the bulbar conjunctiva on which bacteria, particularly the Koch-Weeks bacillus and the pneumococcus, are known to be most numerous. It has the further advantage that it may be conveniently prescribed for use at home.

From the clinical data available, there appears to be little choice among the other common antiseptics. Since the activity of all of them is reduced in the presence of organic matter, preliminary cleansing of the conjunctival sac by irrigation is advisable. In cases in which the cause is the pneumococcus, a freshly prepared 1 per cent solution of ethylhydrocupreine hydrochloride used three times daily is effective.

Chronic Catarrhal Conjunctivitis.—In table 2 is summarized graphically the treatment for some of the forms of chronic conjunctivitis. It is of utmost importance to establish the cause whenever possible.

Chronic Conjunctivitis Due to *H. Lacunatus* (diplobacillus of Morax and Axenfeld): This type is best treated with zinc compounds; the sulfate, employed in from 0.125 to 0.5 per cent solution, is the most popular. A satisfactory routine is to use the 0.25 per cent solution as a collyrium

35. Reese, F. M.: Meningococcus Conjunctivitis Followed by Septicemia and Beginning Meningitis, *Am. J. Ophth.* **19**:780, 1936. Gifford, S. R., and Day, A. A.: Acute Purulent Conjunctivitis Due to the Meningococcus: Report of a Case, *Arch. Ophth.* **13**:1038 (June) 1935.

36. Howard, H. J.: Rationale of Treatment in Some Acute Conjunctival Infections, *J. Missouri M. A.* **29**:193, 1932.

three times daily and to apply the 0.5 per cent ointment to the margins of the lids at night. It is of great importance to treat the margins of the lids, a favorite site of multiplication of the diplobacilli, and to continue the treatment for at least a month after symptoms have subsided in order to prevent recurrence. In my experience the rare cases in which there has been no response to this treatment have been those in which the infection was of the mixed type, *Staph. aureus* usually being the associated bacterium.

TABLE 2.—*Treatment for Some Forms of Chronic Conjunctivitis*

Minute Clinical Examination Slit-Lamp Examination of Cornea		
Simple types	Special types	
Pathogenic bacteria present	No pathogenic bacteria	
1. Conjunctivitis due to <i>Staph. aureus</i> (a) Antiseptics (b) Treatment of margins of lids (c) <i>Staphylococcus toxoid</i>	1. Allergic conjunctivitis (a) Removal of cause whenever possible (b) Symptomatic treatment: (1) Epinephrine (2) Copious irrigations	1. Superficial punctate keratoconjunctivitis (a) Treatment unsatisfactory
2. Conjunctivitis due to diplobacillus of Morax and Axenfeld (a) 0.25% solution of zinc sulfate to conjunctiva (b) 0.5% zinc sulfate ointment to margins of lids (c) Continue treatment 3 months	2. Conjunctivitis of unknown etiology (a) Antiseptics (b) Astringents (c) Miscellaneous (1) Phototherapy (2) Expression of material from meibomian glands (3) Correction of refractive errors	2. Keratoconjunctivitis due to acne rosacea (a) Treatment unsatisfactory
3. Conjunctivitis caused by other bacteria (principally <i>D. pneumoniae</i> and <i>N. catarrhalis</i>) (a) Antiseptics		3. Keratoconjunctivitis sicca (a) Sealing of canaliculi (b) Vitamins
		4. Prexerosis (a) Vitamin A
		5. Conjunctivitis secondary to streptothrix concretions in canaliculi (a) Removal of concretions
		6. Conjunctivitis secondary to verucae and mollusca on margins of lids (a) Removal of tumors
		7. Conjunctivitis secondary to trichiasis, minute foreign bodies, etc. (a) Removal of cause
		8. Conjunctivitis produced by irritants, such as smoke and vapors (a) Removal of cause

Chronic Conjunctivitis Due to Toxin-Producing *Staphylococcus*: This type of conjunctivitis (usually due to *Staph. aureus* but occasionally to *Staph. albus*) frequently resists local treatment. Like the diplobacilli, staphylococci tend to localize on the margins of the lids, which should be treated simultaneously with the conjunctiva. A routine therapy employed with some success at the Vanderbilt Clinic consists of: (1) use of antiseptic collyrium three times daily, (2) application of a 1 per cent solution of silver nitrate to the margins of the lids and of a 0.25 per cent solution to the conjunctiva once or twice weekly, (3) application of a 2 per cent ammoniated mercury ointment to the margins of the lids at night and (4) epilation of lashes if the roots show infection (indicated by thickening and abnormal straightness of the lash and by blackening of its base). If local treatment fails after a trial period

of six weeks or longer, immunization with staphylococcus toxoid is begun. The toxoid is given twice weekly in the dosage recommended by the manufacturer. A small percentage of patients show a hypersensitivity to the preparation, and for them the dose must be reduced. The course may be repeated if necessary.

Chronic Conjunctivitis Due to Other Bacteria: For the most part, this type of conjunctivitis responds well to local treatment. The outstanding exceptions in my experience have been rare cases in which the cause was presumably hemolytic streptococci or *Proteus* and one case in which *Pseudomonas aeruginosa* (*Bacillus pyocyaneus*), *Escherichia coli* and *Klebsiella pneumoniae* (Friedländer) were the causative agents. The patient in the latter case has been under treatment by a number of ophthalmologists over a period of five years.

Chronic Conjunctivitis Due to Allergy: This type is gradually being accepted as a clinical entity. Allergy should be looked for in cases in which itching is the most prominent symptom or in which the ordinary treatment aggravates the condition. The presence of conjunctival eosinophilia is an important diagnostic sign. Treatment consists of elimination of the sensitizing agent whenever possible and in the relief of symptoms by local measures: the use of epinephrine and procaine hydrochloride, copious irrigations with boric acid solution and the use of iced compresses. Desensitization is sometimes of value, as in cases of hay fever conjunctivitis.

In many cases of allergic conjunctivitis the offending agent can be found by means of careful study of the history, without recourse to cutaneous tests. Sensitivity to the drugs employed in ophthalmic practice is common; in my experience sensitivity to physostigmine, atropine, butyn, pontocaine, procaine hydrochloride and mercuric preparations has been observed most frequently. Conjunctivitis due to face powder, rouge, hair dye, eyelash dye and other cosmetics is being commonly recognized. Occupational conjunctivitis is likewise not uncommon. The conjunctival manifestations of allergy have recently been considered in an article by Woods.³⁷

Chronic Conjunctivitis Due to Acne Rosacea: This type of conjunctivitis has been investigated clinically by Verhoeff.³⁸ The treatment generally applied, consisting of dietary restrictions (elimination of tea and coffee and other vasodilators) and application of zinc-ichthammol ointment, has not proved satisfactory. When there is complicating bacterial infection it should be treated appropriately.

37. Woods, A. C.: Clinical Problem of Allergy in Relation to Conjunctivitis and Iritis, *Arch. Opth.* **17**:1 (Jan.) 1937.

38. Verhoeff, F. H.: Personal communication to the author.

Chronic Conjunctivitis of Unknown Etiology: Astringents, such as zinc sulfate, tannic acid and alum, are generally used in the treatment of this type of conjunctivitis. When there is much discomfort, the removal of the superficial layers of the epithelium by the use of silver nitrate or copper sulfate often gives temporary relief. Gifford³⁸ has recommended the use of phototherapy, the conjunctiva being subjected to 75 per cent of the erythema dose for the skin of the patient. Treatments are repeated two or three times a week, and more than six treatments are seldom necessary.

According to Gifford,³⁹ chronic hypersecretion of the meibomian glands may be an etiologic factor in some of these cases owing to the broken-down products of the fatty secretion. He recommended massage of the meibomian glands at intervals for weeks or months. The roles of such conditions as refractive errors and chronic nasal sinusitis are difficult to evaluate, but all such defects should be corrected whenever possible.

By careful clinical study it is often possible to define special types of chronic conjunctivitis which on superficial examination appear non-specific. Thus there exists a frequently occurring form in which slit lamp examination demonstrates the presence of numerous minute punctate epithelial lesions not visible macroscopically. This condition is generally known as superficial punctate keratitis, although it is not identical with the form described by Fuchs. The lesions heal after running a definite clinical course lasting at least three months; in my experience they have not been affected by treatment. Gifford,³⁹ who considered the condition to be a mild epithelial dystrophy, recommended the use of ethylmorphine hydrochloride and alkaline washes. He expressed the belief that the administration of vitamin A has been effective in some cases and suggested that the condition may be a mild form of xerosis. It must be remembered that a variety of conjunctival diseases of known etiology also have associated superficial punctate epithelial lesions; so considerable caution must be exercised in their interpretation.

Some cases of chronic conjunctivitis without demonstrable cause are probably in reality instances of mild keratoconjunctivitis sicca,⁴⁰ in which deficient lacrimal secretion is the principal sign. The condition is seen principally in women during and after the menopause. Beetham⁴¹ has

39. Gifford, S. R.: *Ocular Therapeutics*, ed. 2, Philadelphia, Lea & Febiger, 1937.

40. Sjögren, H.: *General Symptomatology and Etiology of Keratoconjunctivitis Sicca*, *Acta ophth.* **13**:1, 1935.

41. Beetham, W. P.: *Filamentary Keratitis*, *Tr. Am. Ophth. Soc.* **33**:413, 1935.

treated it successfully by sealing off the canaliculi, and von Grósz⁴² recommended general treatment with appropriate endocrine preparations and antianemic agents (liver, iron and arsenic) as well as fibrolysin and vitamin A in oil locally. Vitamin A preparations should also be given by mouth.

Prexerosis, due to mild vitamin A deficiency, is sometimes confused with catarrhal conjunctivitis. It responds well to the administration of vitamin A.

Secondary Conjunctivitis.—Conjunctivitis secondary to streptothrix concretions of the canaliculi responds readily to removal of the concretions. This can usually be accomplished with a fine curet without slitting the canaliculus.

According to reports, removal of the tumors in the rare cases of chronic conjunctivitis secondary to warts⁴³ or molluscum contagiosum⁴⁴ of the margin of the lid has brought about a ready response.

Conjunctivitis secondary to mild trichiasis, minute foreign bodies and irritants heals when the cause is removed.

The conjunctivitis which accompanies chronic dacryocystitis usually heals after extirpation of the lacrimal sac or after restoration of normal drainage by probing or by dacryocystorhinostomy. The latter operation is much to be preferred to extirpation.

SPECIAL FORMS OF CONJUNCTIVITIS

Pseudomembranous Conjunctivitis Due to C. Diphtheriae.—This form of conjunctivitis is treated with diphtheria antitoxin in doses varying from 5,000 to 20,000 units, according to the severity of the disease and the age of the patient. It is preferable to give the full amount indicated intramuscularly in a single dose. All local measures are of decidedly secondary importance, but the local instillation of antitoxin has been recommended. It is generally considered best to leave the membrane untouched, as its removal may increase absorption of toxin. The possibility of atypical forms without pseudomembrane formation, as recently reported by François,⁴⁵ must be kept in mind.

Pseudomembranous Conjunctivitis Due to Hemolytic Streptococci.—Local treatment appears to be without effect in cases of this type.

42. von Grósz, S.: Aetiologie und Therapie der Keratoconjunctivitis sicca, Klin. Monatsbl. f. Augenh. **97**:472; 1936.

43. Vito, P.: Sulla congiuntivite da verruca del bordo libero delle palpebre, Boll. d'ocul. **15**:627, 1936.

44. Wilczek, M.: Molluscum Contagiosum and Trachoma, Klin. Oczna **12**:711, 1934.

45. François, J.: Catarrhal Diphtheritic Conjunctivitis, Brit. J. Ophth. **19**: 1, 1935.

Kluever¹⁹ found that scarlet fever antitoxin brought about temporary disappearance of the membranes in one case, but the disease recurred. Sulfanilamide¹² has given favorable results in cases of puerperal fever and of other hemolytic streptococcic infections; it should be tried in cases of conjunctivitis of this type.

Ocular Pemphigus.—No treatment so far tried has had any apparent marked effect in cases of ocular pemphigus. A favorable effect from roentgen therapy was reported in one case by Bane,⁴⁶ but it failed to modify the disease in three cases under my observation. Arsenic preparations have been administered internally. Gifford⁴⁷ recommended the use of a carotene, viosterol and wheat germ oil mixture to supply vitamins A, B and D. Local treatment to combat trichiasis and secondary infection is indicated, and oily solutions may give symptomatic relief after the establishment of xerosis.

Trachoma.—This condition has been considered by some to be incurable, and it is true that at the dispensaries many persons are seen who have had sporadic treatment over many years without result. With regular treatment over a sufficiently long period, however, healing occurs in the majority of cases. The first requirement for success, without which it is useless to attempt therapy, is the absolute cooperation of the patient. He must understand the nature of his disease, its gravity and the probable length of time required for cure. He should be told that in a case in which there are no complications under the best conditions a year will be required, and that ordinarily it will take considerably longer.

The treatment of trachoma is both local and mechanical and varies with the stage of the disease, according to the relative preponderance of follicular or papillary hypertrophy. There is no specific chemotherapeutic agent active against the virus of trachoma, but experience has shown that the frequent application to the conjunctiva of a cauterizing or strongly irritating agent, such as copper sulfate, will in most instances eventually effect healing. The exact mechanism of this action is not known. The mechanical removal of expressible follicular material is of great value in accelerating the healing process and should be repeated whenever follicles reform. A preponderance of papillary hypertrophy indicates a superimposed bacterial infection or, more rarely, trachoma of high activity; daily applications of silver nitrate continued over a period of a week or two are indicated. Mild bacterial infection may be present in any stage of the disease and may be treated by three daily instillations of a mild antiseptic, such as a solution of mercuric oxycyanide in a concentration of 1:5,000. The occurrence of blepharitis

46. Bane, W. C.: Personal communication to the author.

47. Gifford,²⁸ p. 186.

almost invariably indicates either a diplobacillary or a staphylococcic infection and should be treated accordingly.

In spite of the fact that the corneal changes cause the principal disabilities from the disease, no effective treatment for trachomatous pannus has as yet been developed. In general, the corneal changes have been found to regress after regression of the conjunctival lesions, but this is not always true. When the cornea does not heal, interruption of the blood vessels of the pannus surgically or by diathermic coagulation sometimes helps, and the value of zinc peroxide as recommended by Busacca⁴⁸ is now being tested by me in daily applications. The results so far obtained have been sufficiently good, particularly in the healing of the ulcers associated with pannus, to warrant further clinical trial. Deep ulcers invariably indicate bacterial infection and should be treated accordingly.

A detailed description of the aforementioned procedures follows:

Copper Sulfate: After preliminary anesthesia induced with a 2 per cent solution of butyn, a 1 per cent solution of pontocaine or some similar anesthetic, the stick is applied gently to the conjunctiva of the lids and fornices after eversion with a lid everter. The excess copper sulfate is removed with boric acid solution or physiologic solution of sodium chloride. The application should be graded to the patient's tolerance. The value of the treatment depends in large part on its frequency: Treatments less than three times weekly are probably of little value, and daily application is much to be preferred. Relatives of patients have been successfully trained to perform the treatments under conditions which have prevented daily visits to the office, and in some instances the patient has been able to treat his own eyes. The use of copper sulfate in an ointment or solution does not seem to be of value.

Silver Nitrate: A 1 per cent solution of silver nitrate is applied to the conjunctiva of the everted lids and fornices by means of a cotton applicator. The excess amount is removed by irrigation with physiologic solution of sodium chloride.

Zinc Peroxide: After local anesthesia, about 0.5 Gm. of zinc peroxide is placed or blown into the fornices, and the lids are kept closed for half an hour. The powder is then removed by irrigation; a cotton applicator is useful in removing small particles which may remain.

Expression of Follicles: Local anesthesia produced by instillations of a 4 per cent solution of cocaine and by the injection into the fornices of a 1 per cent solution of procaine hydrochloride with epinephrine is

48. Busacca, A.: Die trachomatöse avaskuläre Keratitis, *Klin. Monatsbl. f. Augenh.* 94:202, 1935.

used for the expression operation. A ring forceps is employed to strip the entire conjunctiva of expressible follicular material. The caruncle and semilunar folds should be similarly expressed; a conjunctival forceps placed through one of the rings of the ring forceps is helpful in grasping the tissues. It is well at the same time to remove the lymphoid accumulation at the upper limbus with a sharp curet. This operation is simple and does not require hospitalization.

Of the many other remedies proposed for the treatment of trachoma, only chaulmoogra oil and quinine bisulfate appear to have gained much popularity. Chaulmoogra oil has been used with success by Gradle and associates⁴⁹ in the campaign against trachoma in southern Illinois, but in my experience it has seemed inferior to copper sulfate.

The various cicatricial complications are treated surgically. The combined tarsoconjunctival excision which used to be commonly employed in the treatment of trachoma in all stages is fortunately going out of favor. In Egypt it is used only occasionally. The entropion which occasionally results is difficult to treat, and the shortening of the conjunctiva interferes with the movement of the globe. The employment of such a radical procedure appears to be unjustified.

A large number of remedies for the treatment of trachoma have appeared in the literature in the past few years. Among them may be mentioned cod liver oil,⁵⁰ locally applied; roentgen irradiation;⁵¹ a snake and bee venom preparation;⁵² iodoform,⁵³ as a powder or an ointment; mercuric cyanide;⁵⁴ benzyl cinnamate;⁵⁵ autohemotherapy;⁵⁶ massage with lump sugar;⁵⁷ ginger;⁵⁸ sodium taurocholate;⁵⁹ massage

49. Lenzen, A. F., and Gradle, H. S.: Treatment of Trachoma, *Am. J. Ophth.* **19**:665, 1936.

50. Possenti, G.: L'olio di fegato di merluzzo per applicazione locale in oculistica, *Rassegna ital. d'ottal.* **5**:96, 1936.

51. Cattaneo, D.: Azione dei raggi roentgen su alcune forme iperplastiche nella congiuntiva tracomatosa, *Rassegna ital. d'ottal.* **3**:661, 1934.

52. Lobel, A.: A propos d'un nouveau médicament dans le traitement du trachome: "Le trachocid," *Ann. d'ocul.* **173**:734, 1936.

53. Stiel, A.: Ueber Probleme der Körnerkrankheit (Trachom), *Ztschr. f. Augenh.* **90**:263, 1936.

54. Shalom, E. S.: Intracorneal Injections of Cyanide of Mercury in Trachomatous Pannus, *Brit. J. Ophth.* **19**:107, 1935.

55. Jacobson, J.: Use of Benzylester of Cinnamic Acid in Ophthalmology, *Sovet. vestnik oftal.* **6**:808, 1935.

56. Zacharov, A.: Autohemotherapy in Trachomatous Pannus and Ulcers of the Cornea, *Sovet. vestnik oftal.* **5**:437, 1934.

57. Murphy, F. G.: Sugar Treatment of Trachoma, *Am. J. Ophth.* **18**:176, 1935.

58. Solotnitzky, J. N.: Le traitement du trachome à l'aide du gingembre, *Rev. internat. du trachome* **12**:34, 1935.

59. Paparcone, E.: Sur la diminution du trachome en Italie, *Rev. internat. du trachome* **12**:202, 1935.

with sodium chloride,⁶⁰ and daily scrapings⁶¹ followed by massage with a solution of mercury bichloride in a concentration of 1:1,000. Sulfanilamide is now being used in the treatment of trachoma by physicians of the United States Indian Service. It appears to have a favorable effect, particularly in the corneal complications of the disease.

Follicular Conjunctivitis.—This type of conjunctivitis is conveniently considered under the classification proposed by Morax:⁶²

1. Follicular conjunctivitis, swimming pool type (inclusion conjunctivitis), heals spontaneously within a year in almost all instances; it is doubtful if treatment of any kind will shorten the course, though Gifford has recommended the use of copper sulfate.

2. Acute follicular conjunctivitis of the Béal type heals within a month. There is no evidence to indicate that treatment shortens the course, but silver nitrate has been employed.

3. Chronic follicular conjunctivitis may require several years for healing. Nothing is known about treating it.

4. Toxic follicular conjunctivitis is an allergic manifestation most commonly due to physostigmine atropine or some other drug.

Folliculosis.—This condition is usually symptomless and requires no treatment. Mild astringents seem to act favorably.

Phlyctenular Conjunctivitis.—General treatment is required for phlyctenular conjunctivitis, since the majority of children who have it are poorly nourished and react positively to tuberculin. An adequate diet supplemented by cod liver oil or concentrates containing vitamins A and D is indicated. General phototherapy is useful. Yellow mercuric oxide or mild mercurous chloride dusted into the eyes daily is commonly employed. The frequent occurrence of pathogenic bacteria on the conjunctiva in these cases has been noted by Axenfeld⁶³ and McKee;⁶⁴ in my experience *Staph. aureus* has been found in over half the cases observed. The removal of the bacteria by appropriate methods has apparently had a favorable effect on the primary disease.

Vernal Catarrh.—Recent work⁶⁵ points to vernal catarrh as an allergic disease, but allergists in general have found it extremely diffi-

60. Shannon, P. A.: Study of Trachoma in Baluchistan, *Indian M. Gaz.* 69:672, 1934.

61. Meyerhof, M., and Habachi, S.: D'un mode particulier de traitement des formes rebelles du trachome (le raclage journalier), *Rev. internat. du trachome* 12:189, 1935.

62. Morax, V.: *Les conjonctivites folliculaires*, Paris, Masson & Cie, 1933.

63. Axenfeld, T.: *Bacteriology of the Eye*, translated by Angus McNab, London, Baillière, Tindall & Cox, 1908.

64. McKee,²⁵ p. 393.

65. Lehrfeld, L.: Vernal Conjunctivitis, *Arch. Ophth.* 8:380 (Sept.) 1932. Woods³⁷

cult to determine significant sensitivities. Local treatment is directed to relief of the itching and irritation, so prominent a feature of the disease. Perhaps the most useful of these are copious irrigations with boric acid solution and frequent instillation of a solution of epinephrine hydrochloride (1:1,000).

Parinaud's Conjunctivitis.—This condition runs a definite course, lasting on the average about three months. According to Verhoeff,⁶⁶ excision of the most prominent nodules seems to shorten the course of the disease.

Conjunctival Tuberculosis.—The prognosis in most cases of conjunctival tuberculosis is favorable. General antituberculous measures along with local applications of ultraviolet rays²⁶ seem to have improved the condition. Tuberculin has been employed.

Oculoglandular Type of Tularemia.—An antiserum has been used by Foshay²¹ and by Kudo²⁰ in a limited number of cases of tularemia. It appears to have shortened the clinical course of the disease.

SUMMARY

An outline of the more important methods in the treatment of conjunctivitis is presented with special emphasis on the value of determining the cause whenever possible. Some of the more important laboratory procedures are summarized, and the mechanism of bacterial infection of the conjunctiva, together with its defensive reactions, is described.

66. Verhoeff, F. H.: Personal communication to the author.

News and Notes

EDITED BY W. L. BENEDICT

SOCIETY NEWS

Postgraduate Course in Ophthalmology.—The tenth special course for postgraduate study in ophthalmology will be given between Oct. 3 and Dec. 7, 1938, under the auspices of the American Medical Association of Vienna at the First and Second Eye Clinics of the Allgemeines Krankenhaus, Vienna, Austria.

The course has been so arranged that the field can be covered systematically and comprehensively in the allotted time. A preliminary knowledge of ophthalmology is presupposed. The entire course is given in English, for a minimum of ten and a maximum of seventeen men. The fee is \$260. Further information can be secured by writing to Prof. Dr. A. Fuchs, Vienna, VIII, Skodagasse 13, or to the American Medical Association, Vienna, VIII, Alserstrasse 9, Cafe Edison.

Medical Society of the State of New York, Section on Ophthalmology and Oto-Laryngology.—The program of the Section on Ophthalmology and Oto-Laryngology of the Medical Society of the State of New York, which will be held on Tuesday, May 10, at the Waldorf Astoria, Le Perroquet Suite, is as follows:

Instruction Hour, 9:00-10:00 a. m.: "Tumors of the Eye and Adnexa," by Dr. Georgiana Theobald, Chicago.

"Compensation for Eye Injuries: Its Past, Present and Future in New York State," by Dr. Albert C. Snell, Rochester, N. Y., with discussion by Dr. D. F. Gillette, Syracuse, N. Y.; Dr. Anton S. Schneider, Plattsburg, N. Y., and Dr. Morris Davidson, New York.

"The Treatment of Tumors of the Lids: By Radiation," by Dr. Hayes E. Martin, New York, and "The Treatment of Tumors of the Lids: By Surgery," by Dr. John M. Wheeler, New York, with discussion by Dr. Arthur J. Bedell, Albany, N. Y.; Dr. Walter S. Atkinson, Watertown, N. Y., and Dr. Ralph I. Lloyd, Brooklyn.

International Organization Against Trachoma.—A meeting of the Executive Committee of the International Organization Against Trachoma was held on Dec. 9, 1937, at the Semiramis Hotel, Cairo, Egypt.

The secretary general read the minutes of the last meeting of the Executive Committee, held in Paris in 1936. The accounts were examined and found to be correct. The subvention given for purposes of research by the American Academy of Ophthalmology and Oto-laryngology, \$100, was allocated to Dr. Poleff of the Pasteur Institute at Rabat, Morocco. It was decided to hold the next meeting of the organization at the same place and at the same time as the next meeting of the International Council of Ophthalmology in 1939.

An assembly of delegates was held on Dec. 10, 1937, at the Semiramis Hotel, Cairo.

A statement was made by the president as to the business to be transacted. The audited accounts were passed. Prof. Manuel Marquez was elected an honorary member of the Executive Committee.

The president, Dr. MacCallan, and the secretary general, Dr. Wibaut, are to remain in office, having been elected for a period of five years at the meeting in London in 1935. According to the statutes, four members of the Executive Committee were due to retire in 1935; however, as all members were due to retire by 1937, it was decided at the 1935 meeting to defer elections until 1937 in order to obtain the presence of the maximum number of delegates.

The president explained that six nations were already represented on the Executive Committee, as follows:

Great Britain, Dr. MacCallan, president

Holland, Dr. Wibaut, secretary general

France, Dr. Bailliart, ex-officio as a representative of the International Association for Prevention of Blindness

United States, Dr. Park Lewis, ex-officio as a representative of the International Association for Prevention of Blindness

Hungary, Professor de Grosz, honorary member

Spain, Professor Marquez, honorary member

There being twelve vacancies on the committee, the president proposed that twelve nations should be represented other than those previously mentioned and that a national representative should be selected by each national group; he also proposed that, as provided in the statutes, no distinction should be made as to vice presidents, members and secretaries. These proposals were accepted.

It was then proposed, seconded and carried that the following nations, being the most trachomatous, should be represented on the Executive Committee: Argentina, Bulgaria, Czechoslovakia, Egypt, Germany, Italy, India, Japan, Lithuania, Poland, Rumania and Turkey.

The meeting was concluded with a vote of thanks to the president.

Subsequently, it was announced that the national groups of the aforementioned countries had selected the following physicians as their representatives:

Argentina, Dr. José A. Séna

Bulgaria, Professor Pascheff

Czechoslovakia, Professor Kadlicky

Egypt, Dr. Tewfik

Germany, Professor Röhrschneider

Italy, Professor Leonardi

India Dr. Mukerjee

Japan, Professor Oguchi

Lithuania, Dr. Avizonis

Poland, Dr. Zachert

Rumania, Professor Michail

Turkey, Dr. Naci Bengisu

German Ophthalmological Society.—The German Ophthalmological Society will meet in Heidelberg, Germany, July 4 to 6, 1938. The principal theme for consideration is the normal and diseased lens, and the subjects will be handled by the following men:

1. Prof. Josef Kampfhauer, Freiberg: "Intermediary Cell Metabolism of the Lens."

2. Prof. Adolf Jess, Leipzig: "The Albumin of the Lens."

3. Prof. H. Süllmann, Basel: "Carbohydrate Metabolism of the Lens."

4. Prof. H. K. Müller, Berlin: "The Genesis of Central Cataract."
5. Docent Dr. Walter Rauh, Leipzig: "Lens and Hormones."
6. Docent Dr. Max Bücklers, Tübingen: "Genesis of Cataract from the Standpoint of Heredity."
7. Prof. Alois Meesmann, Kiel: "The Differential Diagnostic Importance of the Slit Lamp Examination of the Lens."
8. Prof. Wolfgang Stock, Tübingen: "The Operative Removal of the Lens, Including Complicated Cataract and Dislocated Lens."
9. Prof. Heinrich Erggelet, Göttingen: "Optical Correction of the Aphakic Eye."

In addition, there will be two sessions for the reading of papers and a demonstration session.

Tennessee Academy of Ophthalmology and Otolaryngology.—The Tennessee Academy of Ophthalmology and Otolaryngology met in Nashville, Monday, April 11. The officers were Dr. Kate Zerfoss, Nashville, president, and Dr. W. D. Stinson, Memphis, secretary-treasurer. The guest speakers were Dr. Harold Lillie, of the Mayo Clinic, Rochester, Minn., Dr. W. I. Lillie, head of the department of ophthalmology, Temple University, Philadelphia, and Dr. Ernest W. Goodpasture, of the department of medicine, Vanderbilt University, Nashville.

GENERAL NEWS

Postgraduate Course, University of Michigan.—The department of postgraduate medicine of the University of Michigan and the Michigan State Medical Society announce the eighth annual postgraduate course in ophthalmology and otolaryngology at the University Hospital, Ann Arbor, Mich., April 21 to 27, 1938. The first three days of the course will be devoted to otolaryngology, under the direction of Prof. A. C. Furstenberg, and the last three days, to ophthalmology, under the direction of Prof. F. Bruce Fralick.

The fee for the course is \$25, or \$15 for either division, payable on application. If a registrant is unable to attend, the fee will be returned.

Guest lecturers in ophthalmology will be Dr. John O. McReynolds, Dallas, Texas; Dr. Cecil S. O'Brien, Iowa City, and Dr. Cyrus W. Rutherford, Indianapolis. The resident teaching staff will be Dr. F. Bruce Fralick and Dr. Rollo E. McCotter.

UNIVERSITY NEWS

Dr. Parker Heath has been appointed professor of ophthalmology and director of the department of ophthalmology at the Wayne University Medical School, Detroit.

Dr. F. Bruce Fralick has been appointed professor of ophthalmology and director of the department of ophthalmology at the University of Michigan.

PERSONAL

Dr. George H. Mathewson, of Montreal, Canada, formerly professor of ophthalmology at Bishops College and later clinical professor of ophthalmology at McGill University, died suddenly on March 18. He retired from the Montreal General Hospital in 1931.

Correspondence

VITAMIN D AND MYOPIA

To the Editor:—In my article on "Vitamin D and Myopia" in the January issue of the ARCHIVES (19:47, 1938), I stated that I knew of no experiments to determine the amount of calcium in normal and pathologic scleras. There has now come to my attention an article entitled "Myopia and Calcium Metabolism" by Dr. J. Strebel, appearing in the *Klinische Monatsblätter für Augenheilkunde* (99:325 [Sept.] 1937). Strebel states that he showed in an earlier article that the sclera of the human eye with normal vision contained 3 per cent of calcium. He also reports 4 cases of myopia, in each of which the myopia developed after the twenty-fifth year together with disturbances of the calcium metabolism.

JOSEPH LAVAL, M.D., New York.

Abstracts from Current Literature

EDITED BY DR. WILLIAM ZENTMAYER

Biochemistry

CEVITAMIC ACID IN THE AQUEOUS HUMOR. J. FRANTA, *Compt. rend. Soc. de biol.* 126: 110, 1937.

In the rabbit the aqueous contains 20 mg. of reduced vitamin C per hundred cubic centimeters, and the blood, 2 mg. of the oxidized form of vitamin C per hundred cubic centimeters. That the greater vitamin content in the aqueous is due to a hemato-ocular barrier through which the reduced form cannot pass is indicated by several experimental observations. After paracentesis, the titer is lowered for the succeeding week; after enucleation, the vitamin C content of the aqueous becomes reduced by half in seven hours. The aqueous of the rabbit is richer in vitamin C than that of man, which averages about 15 mg. per hundred cubic centimeters; but in human eyes with uveal inflammation the titer diminishes to 3 mg. per hundred cubic centimeters. In children operated on for congenital cataract, the aqueous may attain a normal vitamin C content after several years. Dextrose given intravenously or by mouth to rabbits increases the vitamin C content of the aqueous in from twenty to forty-five minutes. Owing to the difference in diet, the aqueous of the rabbit contains proportionately more vitamin C in summer than in autumn. Hence it is probable that at least part of the vitamin C in the aqueous is derived from the blood.

J. E. LEBENSOHN.

LACRIMAL ELIMINATION OF DEXTROSE IN ALIMENTARY GLYCOSURIA. D. MICHAIL and N. ZOLOG, *Compt. rend. Soc. de biol.* 126: 1042 1937.

Eight normal persons with normal conjunctivas were each given 100 Gm. of dextrose to ingest, and determinations of the sugar in the blood and lacrimal fluid were made every thirty minutes thereafter. Lacrimal elimination of dextrose started in thirty minutes and lasted for ninety minutes, the percentage concentration varying from 0.003 to 0.03, values less than in epinephrine glycosuria. In both alimentary and epinephrine glycosuria the lacrimal gland proved more permeable to sugar than the kidney.

J. E. LEBENSOHN.

Conjunctiva

PROLONGED SIMULATION OF "PETRIFYING CONJUNCTIVITIS." J. SÉDAN, *Ann. d'ocul.* 174: 672 (Oct.) 1937.

In 1913 Sidler-Huguenin, in terminating his article on petrifying conjunctivitis, said that he thought that this condition should be dropped from the ophthalmic literature as the observations made about it did

not correspond to a definite etiology or to a precise clinical entity but depended on the simulation, as shown by the name.

Sédan reports in detail the case of a girl 19 years of age who during a period of ten months of observation had calcareous secretions, more or less abundant, in the conjunctival sac of one eye. Although the condition did not differ essentially from that in other known cases, a striking feature here was the intensity of the corneal lesions. Also notable was the duration of the lesions, the indisputable pithiatism of the pseudomalady and lastly the "relapse" of the condition during an operation for appendicitis.

The patient was observed by Morax from June 1928, when she first presented herself, until April 1929. At the latter time he was convinced that the lesions were provoked, and later when the patient was admitted to the hospital for an appendectomy this was confirmed by the discovery in her clothing of a small box containing two kinds of powder, one white and the other gray, which served to provoke and continue the conjunctivitis.

S. H. McKEE.

A CONTRIBUTION TO THE KNOWLEDGE OF THE IMPORTANCE OF HERPES INFECTIONS IN CORNEAL AND CONJUNCTIVAL DISEASES, ESPECIALLY IN MEMBRANOUS CONJUNCTIVITIS. K. O. GRANSTRÖM, *Acta ophth.* 15: 361, 1937.

The author believes that thin fibrinous membranes on the palpebral conjunctiva constitute a feature of severe unilateral conjunctivitis caused by the herpes virus. In some cases swelling of the preauricular node and fever are present, and often either dendritic keratitis or typical herpetic vesicles of the skin of the lids facilitate diagnosis. Superficial punctate keratitis and disciform keratitis also occur. Transmission of material to the eye of a rabbit will produce typical herpetic keratoconjunctivitis, whereas the usual bacteriologic examinations give negative results. Six cases are reported.

O. P. PERKINS.

Congenital Anomalies

CONGENITAL VASCULAR VEILS IN THE VITREOUS. I. MANN and A. MACRAE, *Brit. J. Ophth.* 22: 1 (Jan.) 1938.

Macrae observed 3 cases of congenital vascular veils in the vitreous in the course of routine examination for refraction. The patients were males aged 17, 20 and 21, respectively. Two were brothers. In all there was a relative amblyopia, 6/12 being the maximum corrected visual acuity. The authors give a detailed description of the fundus in all 6 eyes.

In general terms, the condition may be described as a thin transparent veil lying well forward in the vitreous. The transparency of the veil and the fact that the retina can be seen in position through it show that the veil is not formed of a double fold of the retina but is an additional structure lying in front of it. In some instances there were vesicles in the veils. In one part of their course they were retinal in

origin and in another part they were from the vitreous. In 2 eyes there were choroidal changes in the periphery, and in 1 eye there was a shallow detachment.

The authors discuss fully the etiologic possibilities of this condition. They state that it seems probable that the veil is in the nature of a condensation of vitreous and that in its commencement it was in contact with the inner layer of the optic cup. It may be similar to the vascular condensation of vitreous sometimes seen in cases of congenital retinal fold. The authors favor the view that the vessels in the veil may be retinal vessels which have secondarily grown into the vitreous condensation, where it is abnormally adherent to the retina.

The article is illustrated.

W. ZENTMAYER.

Cornea and Sclera

TREATMENT OF HERPETIC KERATITIS WITH VITAMIN B. J. NITZULESCU and E. TRIANDAF, *Brit. J. Ophth.* 21: 654 (Dec.) 1937.

Two cases of herpetic keratitis are reported in which vitamin B was administered.

The first case was that of a 16 year old boy. The initial condition was gonorrheal conjunctivitis. After the conjunctival secretion had disappeared, vesicles appeared on each cornea. Usual methods of treatment failed to relieve the intolerable pain. Injections of vitamin B₁ were given, and in ten days the corneal lesions had cleared except for a single area of infiltration.

The second case was that of a woman aged 33. In the right eye there was a corneal nebula resulting from an inflammatory condition at the age of 3. In the left eye there was herpetic keratitis. The condition rapidly improved under local treatment and the injection of Vitamin B₁.

While 2 cases are insufficient on which to base definite conclusions, the authors believe that the result of the treatment was more than a coincidence, and they are encouraged to propose vitamin B₁ therapy in cases of herpetic keratitis and generally in cases of all painful and neurogenic conditions of the cornea.

W. ZENTMAYER.

ETIOLOGY OF KERATOCONUS. E. DE SANCTIS, *Ann. di ottal. e clin. ocul.* 65: 279 (April) 1937.

The physical findings and the results of roentgenographic examination of the skull in five cases of keratoconus were recorded. In no case was any information obtained which seemed of significance in regard to the etiology. One patient was a mongolian idiot with bilateral cataract. No evidence was found of endocrine imbalance. In three cases the sella turcica was larger than normal, although no signs of pituitary insufficiency were present. The author believes that it is possible that abnormalities of the hypophysis may have been responsible for the increase in the size of the sella turcica and also for the keratoconus without having produced any clinical signs of glandular imbalance.

S. R. GIFFORD.

HEMATIC INFILTRATION OF THE CORNEA. C. S. DAMEL, Arch. de oftal. de Buenos Aires 12: 18 (Jan.) 1937.

In connection with a case of traumatic infiltration of the cornea, with the production of a permanent corneal opacity and visual reduction to perception of light, Damel reproduces a lengthy and interesting medico-legal report to the courts of justice of Buenos Aires, in which he details and calculates the amount of the resulting damage and visible incapacity in accordance with modern standards.

C. E. FINLAY.

Experimental Pathology

INFLUENCE OF VITAMIN C ON RESISTANCE TO EXPERIMENTAL CONJUNCTIVAL DIPHTHERIA. H. BOCK and G. GROSZMANN, Monatschr. f. Kinderh. 65: 35 (Jan.) 1936.

It is well known that various persons differ in their resistance to specific infections. The authors' interest was centered on the effect on the resistance of guinea-pigs to induced conjunctival diphtheria of vitamin C added to their regular diet. The literature on previous attempts of this nature is reviewed. The guinea-pigs were sorted into six groups. Group 1 had a diet free from vitamin C. Group 2 had a normal diet. Groups 3, 4 and 5 had a normal diet with 10, 30 and 50 mg. of vitamin C, respectively, added to the diet each day. Group 6 had the normal diet with 175 mg. of vitamin C added daily during the first six days and then 75 mg. In each animal on the twentieth day of the diet the conjunctiva of the lower lid of one eye was cocaineized and seared with a glowing spatula and the conjunctiva of both eyes was then swabbed with viable cultures of diphtheria. The diet was continued. All of the scorbutic guinea-pigs were dead in sixteen days. All the guinea-pigs in the other five groups lived. The following tabulation demonstrates the types of infection noted:

Observation	Incidence in Group					
	1	2	3	4	5	6
	Scorbutic Diet	Normal Diet	Normal Diet + 10 Mg. Vitamin C	Normal Diet + 30 Mg. Vitamin C	Normal Diet + 50 Mg. Vitamin C	Normal Diet + 175 Mg. Vitamin C
No lesion.....	0 (0%)	6 (27%)	13 (59%)	14 (64%)	9 (41%)	14 (64%)
Keratoconjunctivitis.	0 (0%)	10 (46%)	9 (41%)	3 (14%)	2 (18%)	7 (32%)
Ulcer of cornea.....	8 (36%)	0 (0%)	0 (0%)	4 (18%)	2 (9%)	0 (0%)
Panophthalmitis.....	14 (64%)	6 (27%)	0 (0%)	1 (4%)	7 (32%)	1 (4%)
Total.....	22 (100%)	22 (100%)	22 (100%)	22 (100%)	22 (100%)	22 (100%)

The authors conclude that animals on a normal diet to which from 10 to 30 mg. of vitamin C is added daily are more resistant to experimental diphtherial conjunctivitis.

L. L. MAYER.

General

ASSOCIATED SYMPTOMS IN OPHTHALMOLOGY. P. WEINSTEIN, Ann. d'ocul. 174: 679 (Oct.) 1937.

Diagnostic errors occur not only from misinterpreting characteristic symptoms but from not recognizing secondary groups of symptoms

similar to the dominant ones. Thanks to the development and perfection of instruments, one is able more and more to diagnose such conditions and to treat both of them at the same time, assuring complete recovery.

Observations on the following combinations of diseases are detailed: tabes and nicotine-alcoholic neuritis, tabes and syringomyelitis, simple glaucoma and suprasellar calcification, embolus of the cuneus and sellar calcification, thrombosis of the central vein of the retina with intra-ocular tumor and absolute glaucoma and chronic inflammatory glaucoma and cerebral arteriosclerosis.

These associations confirm the connection that exists between ophthalmology and other branches of medicine, which the practitioner may ignore.

S. H. McKee.

General Diseases

DERMATOLOGICAL ASPECT OF AFFECTIONS OF THE EYE. G. B. DOWLING, *Brit. M. J.* 2:794 (Oct. 23) 1937.

The author, a dermatologist, devotes much space to a consideration of rosacea. Slight digestive disturbances are frequently regarded as the cause, but in at least one half of the cases no symptoms of these disturbances were elicited. The author was impressed with the frequency of a life-long vasomotor disturbance. The causes seem to be faulty diet and hygiene. A case is cited in which a patient improved remarkably on a strict diabetic diet. One investigator found a low hydrochloric acid content in 48 per cent of the cases studied: Excessive drinking of tea is often an important factor; the menopause, during which vasomotor disturbances may be accentuated, is also a principal cause. In the consideration of blepharitis, it is important to draw a sharp line of distinction between seborrhea and dandruff. Dowling divides cases of dermatitis of the eyelids into four groups: (1) those of infective dermatitis, (2) those in which the condition is due to irritation by chemical substances, (3) cases of seborrheic dermatitis and (4) cases in which there was no known cause for the dermatitis. The last group is, unfortunately, the largest. Local treatment is difficult. Under a miscellaneous classification, lupus vulgaris, lupus erythematosus, basal cell epithelioma, pemphigus, warts and xanthelasma are described. Xanthelasma is best treated by a minor operation, such as one described by Kromayer in which the tumor is easily shelled out under local anesthesia. Some dermatologists treat this condition with trichloroacetic acid.

ARNOLD KNAPP.

ARACHNODACTYLIA. J. MALBRÁN and H. R. PÍCOLI, *Arch. de oftal. de Buenos Aires* 12:3 (Jan.) 1937.

After a detailed review of the literature on the symptomatology of arachnodactylia and the influence of heredity since this disease was first described by Marfan in 1896 as "dolichostenomelia" and a full discussion of the different theories concerning etiology, the authors report a series of cases in 2 families.

In the first family a father and 3 children were affected. (Two other children were not examined but were reported to have sound

eyes.) The father did not have any osseous lesions, and ocular examination revealed atrophy of the iris, subluxation of the lens, detachment of the retina and atrophy of the optic nerve in one eye and subluxation of the lens in the other eye. The mother was healthy. A boy aged 14 years had irregular development of the feet and cardiac lesions (pulmonary sclerosis). The right eye showed subluxation of the lens upward and choroidal lesions, and the left eye, subluxation of the lens. A girl aged 10 years had flat feet, elongated toes and fingers and aortitis. There was subluxation of the lens in each eye. A girl aged 6 years had dolichocephalic hands, arachnodactylia, lordosis, aortic sclerosis and dilatation of the heart. Examination of her eyes showed miosis and luxation of the lens upward; the fundi were normal.

In the second family the mother and 3 daughters (of 7) were examined. The mother had syphilitic iritis, was tall and presented lordosis, marked development of the hands and feet (her father was also large) and elongation of the fingers and toes, which were not deformed. Examination of her eyes showed deposits of pigment on the posterior surface of the cornea and the anterior lens capsule and no luxation of the lens. Of the 3 daughters, only 1 showed signs of the disease. She was aged 12 years, was retarded in development and had Hutchinson teeth, a broad nose, rhagades and a high palate. She was above normal in stature; the long bones were markedly developed, and the hands showed indications of arachnodactylia. She had lordosis and flat feet. The right eye showed microphthalmia, with microcornea and luxation of the lens upward. The lens was opaque, with broad synechia at the inferior pole, vascular penetration and no vision. The left eye showed microphthalmia and microcornea. The cornea was transparent, the lens normal and the vitreous clear. Doyne's choroiditis was present at the posterior pole of the eye, and there were peripheral pigmentary changes. Vision with correction of the refractive error (myopia) was 1.

C. E. FINLAY.

Glaucoma

POTASSIUM-CALCIUM INDEX AND EPINEPHRINE CONTENT IN THE BLOOD IN CASES OF GLAUCOMA. E. TRON and A. ODNASHEVA, *Vestnik oftal.* 11: 1, 1937.

A review of the literature is given on two antagonistic views concerning the influence of the sympathetic nervous system in cases of glaucoma: its depressive and its irritative action. With a number of biochemical tests, Passow found an increase in the iodine content of the blood of glaucomatous patients or thyrotoxicosis and an increase in the tonus of the sympathetic nervous system due to a low potassium-calcium index. He also found an increase in the epinephrine content of the blood, which indicates a hyperfunction of the chromaffin system of the adrenal glands.

Because of the controversial opinions and in order to verify Passow's findings, Tron and Odnasheva attempted to determine the potassium-calcium index of the blood as one of the signs of the tonicity of the vegetative nervous system. The potassium content of the blood was

determined by the Kramer-Tisdall method and the calcium content by the De-Vaard method. Twenty-five patients with simple and inflammatory glaucoma and 20 control patients were examined. The results of the tests are presented in three tables.

Tron and Odnasheva also used the Kravkov method (on an isolated rabbit's ear) to determine the epinephrine content of the blood serum of 14 patients suffering from primary glaucoma and of 14 control patients. The test, which is described in detail, shows chiefly the vasoconstrictor action of normal serum and that of the serum of glaucomatous patients. The results were as follows:

1. The calcium content in the serum of 25 glaucomatous and 20 control patients was about equal, the values being 10.28 and 10.38 mg. per hundred cubic centimeters, respectively.

2. The potassium content was higher in the serum of the glaucomatous patients than in the serum of normal patients. The average for the first group was 25.48 mg. per hundred cubic centimeters; for the second group, 22.12 mg. The potassium-calcium index of the blood serum for patients with glaucoma was 2.45 and for the control patients, 2.14; this slight difference is not reliable, so that no preference can be given in favor either of sympathicotonicity or of vagotonicity.

3. The determination of the content of vasoconstrictor material in the serum of glaucomatous patients after Kravkov's method (on an isolated rabbit's ear) showed an increase of epinephrine in 11 of 14 patients. This factor, i. e., the influence of the adrenal glands on the pathogenesis of glaucoma, can be evaluated only after a determination of the frequency of glaucoma in association with general diseases which are accompanied by an increase in the epinephrine content of the blood serum.

O. SITCHEVSKA.

GLAUCOMA-LIKE CUPPING OF THE OPTIC DISK AND ITS ETIOLOGY. E. D. NIELSEN, *Acta ophth.* 15: 151, 1937.

This article deals with cases in which glaucoma-like cupping of the optic nerve is present and in which increased intra-ocular tension either is not demonstrable or is demonstrable only with difficulty. There is a brief historical survey, followed by a presentation of 12 cases studied by the author.

Examinations of the visual fields, plottings of twenty-four hours' tension, water tolerance tests and roentgenographic examinations were performed in these cases and served to establish the diagnosis of glaucoma in 5. In 3 other cases glaucoma was thought to be complicated by changes in the optic nerve of traumatic or arteriosclerotic origin. In 2 cases the cupping was held to be due to pressure atrophy, the result of a tumor of the brain and in 1 case it was probably due to a congenital malformation. In another case it proved impossible to find any natural explanation for the cupping.

The author emphasizes the diagnostic value of perimetry and feels that the water tolerance test is also a great aid, more so than tonometry over a twenty-four hour period.

O. P. PERKINS.

Instruments

ASPIRATING CUP FOR EXTRACTION OF CATARACT. J. LIJÓ PAVÍA, Arch. de oftal. de Buenos Aires 12: 147 (March) 1937.

A third model of an aspirating cup, attached to an aspirating syringe, is described. As in the other models, the vacuum is produced by drawing out the piston, a catch preventing its going back, and the vacuum is communicated to the cup by pressing a button. This model differs from the other models, which have an aspirating power of only 35 Gm., and from Arruga's model, which has an aspirating power of 50 Gm., in that the degree of aspiration produced reaches 100 Gm.

C. E. FINLAY.

Lacrimal Apparatus

DIVERTICULUM OF THE UPPER LACRIMAL CANALICULUS IN THE HUMAN FETUS. O. BARATTA, Ann. di ottal. e clin. ocul. 65: 446 (June) 1937.

Baratta sectioned a 100 mm. embryo and found a diverticulum opening into the upper canaliculus at an acute angle. It passed into the upper lid external to the canaliculus and was patent in its proximal two thirds. He examined a number of fetuses ranging from 100 to 250 mm. in length and found evidence that such diverticula in a rudimentary form are not so rare as has been supposed, although in most cases the epithelial columns representing such rudiments may never become patent. Clinical cases in which diverticula developed in later life are reviewed.

S. R. GIFFORD.

Lens

OPACITIES OF THE LENS IN CASES OF PSORIASIS. E. TROVATI, Ann. di ottal. e clin. ocul. 65: 256 (April) 1937.

The literature on cataracta neurodermatica is reviewed. Trovati examined all patients with psoriasis in the dermatologic clinic at Genoa with especial reference to opacities of the lens. Of fifty patients, six showed changes in the lens, which in some instances were detectable only with the slit lamp. Examination of patients with other cutaneous conditions, including twenty with chronic eczema and eight with scleroderma, did not reveal any opacities which could be considered to form a true cataract. The opacities in the patients with psoriasis had not produced marked loss of vision, which was still normal in most instances. A slowly progressive increase in the opacities was noted in these patients. The opacities affected the deeper layers of the anterior cortex, the sub-capsular layers being transparent. A few opacities were seen in the posterior cortex. They were chiefly in the periphery of the lens, with a radial distribution. General examination, including studies of glandular function and of blood chemistry, revealed no significant abnormalities. The ages of the patients varied from 21 to 37.

S. R. GIFFORD.

THE ISO-ELECTRIC POINT OF THE CRYSTALLINE LENS IN EXPERIMENTAL PARATHYROIDOPHY. T. MAESTRO, *Ann. di ottal. e clin. ocul.* 65: 453 (June) 1937.

By the precipitation method, Maestro studied the iso-electric point of the lenses of parathyroidectomized rabbits, including cataractous lenses and those which remained clear. Both lenses of 4 animals were examined after thyroidectomy, while one lens was removed from each of 4 other animals and used as a control before operation. Four normal animals were used as controls.

The normal iso-electric point was found to be approximately pH 5, and no second iso-electric point was found. In parathyroidectomized animals a slight but constant lowering of the iso-electric point, to about pH 4.8, was noted. The same change was found both in clear lenses and in those presenting opacities. There is, hence, no experimental evidence that a change in the iso-electric point nearer to neutrality occurs after parathyroidectomy which could be assumed as a cause of the opacities of the lens.

S. R. GIFFORD.

VISUAL ACUITY AFTER BILATERAL OPERATION FOR CATARACT IN EARLY CHILDHOOD. W. KISS, *Klin. Monatsbl. f. Augenh.* 98: 523 (April) 1937.

Kiss reports on the results obtained by bilateral operation for cataract in early childhood at the University Eye Clinic of Innsbruck. Of 23 children operated on during the first six years of life, 21 could be traced, but the results obtained on 1 were omitted from the report because the child had not completed the third year of life. Linear extraction or discission was done as indicated in each case. Several operations were required in some cases, such as discission, iridectomy and abscission of prolapses. It was found that iridectomy and abscission of prolapses led to severe complications during the first year of life. This was due to especial vulnerability of the iris at this age, as pointed out by Elschmig. Discission sufficed in patients with membranous, or greatly shrunken, cataracts. Congenital total cataract was operated on during the first year of life, if possible. Of the 38 eyes operated on, 6 became blind, 3 after secondary operations were done elsewhere. Kiss compares his results with those obtained at other ophthalmic hospitals and arrives at the following conclusions: Hardly one half of the children who are born practically blind acquire sufficient vision on operation to attend school or to engage in an occupation. All of the children, on the other hand, who possess a certain amount of vision prior to the operation obtain sufficient vision. The unfavorable results in the first group are due to complications encountered during or after the operation. They are brought on in consequence of the peculiarity and poverty of the country, which render proper postoperative care impossible.

K. L. STOLL.

Lids

THE TREATMENT OF SEBORRHEIC BLEPHAROCONJUNCTIVITIS. W. B. CLARK, *Am. J. Ophth.* 20: 808 (Aug.) 1937.

Clark draws the following conclusions concerning the treatment of seborrheic blepharoconjunctivitis:

"1. Seborrhic blepharoconjunctivitis is a more prevalent problem than the ophthalmological literature indicates.

"2. It is amenable to treatment that can be administered by any eye physician without the use of expensive additional equipment.

"3. The treatment must be carried out over a long period of time. Recurrences are to be expected, but persistence and patience in treating this condition will be rewarded."

W. S. REESE.

MIMICAL ECTROPION OR ENTROPION OF THE EYELIDS: MONOLATERAL AND BILATERAL. S. HOLTH, *Acta ophth.* 15: 370, 1937.

This curious item deals with the unique accomplishments of 2 brothers. One of them, after a series of facial gymnastics, is able completely to evert one or both upper eyelids. The other can roll in one or both lower lids.

Photographs show some of the contortions, together with the end results.

O. P. PERKINS.

Neurology

UNILATERAL HEREDITARY AND CONGENITAL IRRITATION OF THE CERVICAL PORTION OF THE SYMPATHETIC TRUNK: REPORT OF A CASE. P. M. GEORGARIOU, *Klin. Monatsbl. f. Augenh.* 98: 306 (March) 1937.

Georgariou introduces his paper with remarks on the importance of the sympathetic trunk, especially its cervical portion, to the ophthalmologist. He adduces the literature in point, mentioning that in most of the reports a disturbance of this part of the nervous system was considered a secondary complex. His case of chronic hereditary congenital irritation of the cervical portion of the sympathetic trunk differs in this respect, as the disturbance was primary. It is the first case of this kind to be reported since that published by Michel in 1903, which is the only other case in this category. Michel's patient was a 9 year old boy.

Georgariou's patient, a young woman, and some other members of her family had had a large palpebral fissure in one eye since birth. The large fissure in the young woman was in the left eye. The left upper lid was 3 mm. higher than the right, and a slight spastic strain was evident when she attempted to close the eye; the lid did not follow the eye when she looked down. The pupils were equal and reacted normally. Coppez's test with epinephrine and cocaine gave a normal reaction. The extrinsic muscles of the eye were undisturbed, and lagophthalmos was absent. Vision was normal in each eye, and no ocular symptoms were found, except slight narrowing of the retinal vessels

in the right eye. No secretory anomalies, such as a disturbance of perspiration, existed, and the Wassermann and Mantoux tests were negative. Georgariou discusses whether an irritation of this type is due to a direct or an indirect cause, whether pressure of the thyroid gland on the sympathetic trunk may produce the irritation, whether endocrine disturbances may be instrumental or whether an infection due to a neuropathic virus may be the cause in some cases. Georgariou does not agree with Michel's opinion as to a neuropathic hereditary etiology. He considers the elevation of the lid and its limited concomitant motion on downward gaze to be the result of a slight congenital anomaly of the tissues or vessels, which causes a chronic irritation at a certain point in the cervical portion of the sympathetic trunk. Hitherto unknown laws of heredity transmit this anomaly from generation to generation.

K. L. STOLL.

Ocular Muscles

DIVERGENT STRABISMUS. E. E. CASS, *Brit. J. Ophth.* 21: 538 (Oct.) 1937.

Cass reviews the various conditions which have been assigned as causes of divergent strabismus and gives an analysis of eighty-eight cases of this condition. The article should be read in the original, as the statistical features do not lend themselves to abstraction.

W. ZENTMAYER.

TREATMENT OF CONCOMITANT SQUINT BY ORTHOPTIC METHODS. G. G. PENMAN, *Brit. M. J.* 2: 1019 (Nov. 20) 1937.

In determining which patients with concomitant squint are suitable for treatment by orthoptic methods, Penman considers age, intelligence and psychologic state, refraction, vision and retinal correspondence. The average period of attendance for each patient in the "squint department" at the Royal Westminster Ophthalmic Hospital is forty-eight days. After treatment is completed, the patient is seen at intervals of from one to three or more months.

As a result of his experience, Penman prefers to operate on persons between the ages of 12 to 14, because local anesthesia can be used and necessary adjustment of the eyes can be better determined. Also, there is a possibility of the squint's straightening of its own accord if one does not operate sooner. There are other factors, such as the psychologic state, circumstantial elements, the amount of squint and the results of orthoptic training, which allow operation at an earlier age.

The patients who do best with orthoptic treatment are those with squint of a slight degree, especially of the accommodative type. For the others, treatment combined with operation offers a physiologic cure except when there is persistent amblyopia, false projection or complete lack of fusion sense.

In conclusion, Penman states that at the Royal Westminster Ophthalmic Hospital nearly half of the patients with concomitant squint have had to have an operation. At the same time the standard of the results of treatment is now much higher than in the old days when the

cosmetic appearance was the only criterion. In the author's opinion, there is no doubt that operation is needed less often than formerly, that the operative results are better and more permanent and that a second operation may be avoided if orthoptic treatment is followed. In brief, orthoptic treatment is a valuable adjunct and makes for a much higher percentage of real successes.

ARNOLD KNAPP.

Physiology

INFLUENCE OF THE ADMINISTRATION OF WATER ON THE ARTERIAL BLOOD PRESSURE AND ON INTRA-OCULAR PRESSURE: CLINICAL AND EXPERIMENTAL RESEARCH. V. SPADAVECCHIA, *Ann. di ottal. e clin. ocul.* 64:611 (Sept.); 697 (Oct.) 1936; 65:194 (March) 1937.

Spadavecchia reviews the status of the problem of the relation between arterial blood pressure and intra-ocular pressure. A study is made of the changes in systolic and diastolic blood pressure that take place for twelve hours after the ingestion of 1,500 cc. of water given from 8 to 8:30 in the morning after a fast of twelve hours. The changes in arterial pressure with respect to the original blood pressure, the cardiac and renal status and the role played by the anatomic and functional status of the arteries in producing these changes during the test are analyzed.

After making a study of the influence of body position on intra-ocular pressure in normal eyes, Spadavecchia proceeds to consider the changes in intra-ocular pressure produced in 29 patients (56 eyes) during the foregoing tests. The eyes were a mixed group, i. e., normal and glaucomatous eyes with normal and pathologic capillary beds. The author concludes that the intra-ocular pressure depends on the condition of the arterial bed of the eye and that there is a limit of separation between general arterial pressure and intra-ocular pressure. This he calls the "endocular threshold," or the "threshold of intra-ocular pressure." Its high physiologic level may be altered by various morbid and premorbid local conditions, especially those associated with the arterial system.

F. P. GUIDA.

THE VALUE OF MUSCULAR WORK IN THE REGULATION OF THE INTRA-OCULAR TENSION. V. P. FILATOV, *Vestnik oftal.* 11:151, 1937.

Filatov presumes that the intra-ocular tension is higher in the morning than in the evening because substances of fatigue are lacking in the blood after the muscles have a night's rest. Clinical and experimental observations were made in order to verify this hypothesis.

A patient who suffered from frequent attacks of absolute glaucoma in one eye and chronic inflammatory glaucoma in the other eye, with high tension which did not respond to the use of myotics, was ordered to walk and climb stairs from one to two hours every morning on awakening. Two weeks later the glaucomatous attacks ceased and the tension was lowered, so that it was possible to do a trephine operation

with good results. This patient and two others with similar symptoms were observed for a period of about eighteen months.

In dogs and rabbits which were made to race, the intra-ocular tension was lowered after racing. Further study on this subject is being done at the Odessa Eye Clinic and the Experimental Institute in Kiev. The following conclusions were arrived at:

1. Muscular work aids the regulation of tension in cases of glaucoma.
2. In human beings physical exercises cause an increase of the blood pressure and a decrease of the intra-ocular tension.
3. The intra-ocular tension is lowered in animals fatigued from racing.
4. The blood of such animals acquires the quality of lowering the intra-ocular tension of control animals when introduced into their blood.

O. SITCHEVSKA.

Refraction and Accommodation

THE AVOIDANCE OF DYNAMIC ACCOMMODATION THROUGH THE USE OF A BRIGHTNESS-CONTRAST THRESHOLD. M. LUCKIESH and F. K. MOSS, *Am. J. Ophth.* 20: 469 (May) 1937.

Luckiesh and Moss give the following summary:

"The sensitometric method possesses the following indicated characteristics: dynamic accommodation is controllable without the use of drugs and without inhibiting tonic accommodation; and the significance of subjective refraction is enhanced due to the precision and reliability of the subjective data obtainable. Obviously much additional clinical research is necessary to evaluate the clinical significance of these conclusions. The major purpose of this discussion is to suggest such researches."

W. S. REESE.

HOW AND WHY IT IS POSSIBLE TO CORRECT AND MEASURE HYPEROPIA WITH A SPHEROCONCAVE MIRROR. G. GALLERANI, *Ann. di ottal. e clin. ocul.* 64: 801 (Dec.) 1936.

By placing a lens with an inner base curve of $+5.00$ D. at a distance of 8 mm. in front of the cornea of an eye with 6.00 D. of hyperopia, it was found that objects at a great distance behind the patient were reflected by the inner surface of the lens so as to be seen distinctly by the patient. Varying the distance from the cornea of a concave mirror of the same curvature resulted in correction of different degrees of hyperopia. Mirrors of other curvatures could be used to correct other hyperopic errors by placing them at the original distance of 8 mm.

The remainder of the paper does not lend itself to abstracting, as it is a diagrammatic analysis of the optics concerned.

The author feels that a mechanism incorporating such a mirror could be designed for estimating refractive errors.

F. P. GUIDA.

Retina and Optic Nerve

RETINITIS OF PREGNANCY. J. N. DUGGAN and V. K. CHITNIS, *Brit. J. Ophth.* 21: 585 (Nov.) 1937.

The authors report 3 cases of retinitis of pregnancy. In the first case the retinitis was of the characteristic form; in the second case it was of the type associated with the toxemia of pregnancy which is complicated by chronic nephritis, and in the third case the retinitis resembled that in the first case in some respects, yet its nature remained obscure.

The authors conclude that there is only one type of retinitis which can be called the retinitis of pregnancy, that described by Semple and characterized by sudden onset, edema of the retinal tissues, equally sudden cessation on removal of the cause and complete restoration of vision.

Whenever chronic nephritis complicates pregnancy, the visual disturbances are due to renal retinitis. This type of retinitis is associated with high blood pressure, which, together with the signs of retinitis, have a tendency to persist after delivery. This form of retinitis serves as a useful guide in differentiating chronic nephritis complicating pregnancy from preeclamptic toxemia. It should really be classed with the retinitis which is associated with hypertension and chronic nephritis preceding pregnancy.

Apart from their differentiating value, the lesions of the retina are of aid in estimating the damage done to the vascular tree.

In the presence of beginning retinitis, the ophthalmologist should not hesitate to advise interruption of the pregnancy.

W. ZENTMAYER.

THE ANATOMY OF THE CROSSINGS OF RETINAL VESSELS. L. SALLMANN, *Arch. f. Ophth.* 137: 619 (Oct.) 1937.

The author has made systematic anatomic studies of the crossings of retinal vessels of persons with and without hypertensive vascular disease. The studies were made on the eyes of cadavers removed as shortly after death as possible. The eyes were fixed in formaldehyde and opened by an equatorial section. With the aid of a loupe, several crossings of retinal vessels with the surrounding retina were excised, embedded in paraffin and sectioned serially. The sections were stained with eosin and hematoxylin, with Van Gieson's stain and with Weigert's elastica stain. Altogether, 129 crossings were studied. These were taken from the eyes of 27 persons who had shown no signs of hypertensive cardiovascular disease. The number of persons and their respective ages at the time of death were as follows: between 20 and 40, 9 patients (group 1); between 40 and 60, 8 patients (group 2), and between 60 and 76, 10 patients (group 3). In addition, the eyes of 5 patients who had had essential hypertension (group 4) and of 5 patients who had died from nephrosclerosis (group 5) were studied. No persons were included in groups 1, 2 and 3 in whom the fatal disease might have affected the ocular vessels.

The study of eyes from persons who had been free from hypertensive disease revealed the following facts:

1. At the crossings the artery and the vein always come in direct contact with each other. The extent of the contact varies.

2. At the crossings one commonly sees an exchange of adventitial fibers between the two vessels.

3. At the crossings the vein may lie above (toward the vitreous) or below (toward the choroid) the artery.

4. Even in young persons without vascular disease the vessels (artery and vein) deviate from their normal straight course at the crossings. In dodging the artery the vein may describe a loop into the outer nuclear layer of the retina. Such a behavior of the vessels at the crossings must, therefore, not be considered as a pathologic phenomenon.

5. With increasing age, the artery becomes more rigid and tends to deviate less at the crossings. In addition, the walls for both vessels become thickened at the crossings, and the number and thickness of the adventitial connecting fibers increase.

Sallmann found that the thickening of the walls of the vessels at the crossings was more pronounced in the eyes of persons who had had essential hypertension than in those of persons of the same age who had been free from hypertensive disease. The eyes of persons who had had nephrosclerosis revealed severe hyaline degeneration of the walls of the vessels and narrowing of the lumens. In those from persons who had had hypertension there often was a distinct adventitial sheath which surrounded both vessels and made it impossible for the vein to move away from or to dodge the artery.

The lower degrees of "nicking" of the veins, therefore, are due to an indentation or deformation of the veins caused by a thickening of the arterial wall, whereas the higher degrees are caused by definite sclerotic changes.

P. C. KRONFELD.

Trachoma

STUDIES ON THE INFECTIVITY OF TRACHOMA. R. W. HARRISON and L. A. JULIANELLE, *Am. J. Ophth.* 20: 360 (April) 1937.

Harrison and Julianelle give the following conclusions and summary:

- "1. In vitro cultivation of the infectious agent of trachoma has been attempted by tissue-culture methods.

- "2. Tissue cultures from six different animal species have been employed, under a variety of conditions.

- "3. The temperature range during incubation varying from three to eight days has been from 30 to 37.5° C., and the tissue cultures were incubated aerobically and anaerobically.

- "4. Elementary or initial bodies have never been found in any of the tissue cultures.

"5. None of the tissue cultures inoculated in monkeys were able to induce experimental trachoma, even though in many cases the materials from which they were derived were of demonstrable infectivity.

"6. The results indicate an inability of the infectious agent of trachoma not only to multiply but even to survive under the stated conditions of tissue culture.

"7. The data suggest that the infectious agent is characterized by a highly organized tissue specialization which renders in vitro cultivation extremely difficult with the knowledge available at the present time."

W. S. REESE.

Tumors

PLEXIFORM NEUROFIBROMATOSIS (VON RECKLINGHAUSEN'S DISEASE)
INVOLVING THE CHOROID, CILIARY BODY, AND OTHER STRUCTURES.
J. M. WHEELER, *Am. J. Ophth.* 20: 368 (April) 1937.

Wheeler reports a case of neurofibromatosis in a 6 year old girl who was first seen by him in 1929 but who was observed by other colleagues from birth. The right eye was blind and buphthalmic, and the skin of the right upper lid was dark. This lid was completely ptosed, with a tumor-like mass covered by conjunctiva hanging down below the margin of the lower lid and causing ectropion of the outer two thirds. The soft parts of the malar and temporal regions of the right side were thickened, and this tissue had a cordlike feel. Investigations revealed neurofibromatous involvement of the right upper lid, zygomatic and temporal regions, lacrimal gland, apex of the orbit, ciliary body, choroid, sclera and optic nerve. Roentgenographic examination pointed to probable involvement of the hypophysis and structures in the middle fossa of the right side of the skull. The chiasm and optic tract were apparently not seriously involved.

W. S. REESE.

Uvea

THE DEVELOPMENT OF THE PIGMENTED RING LINE OF THE IRIS.
L. SALLMANN, *Arch. f. Ophth.* 137: 510 (Oct.) 1937.

Of twenty-eight cases in which Lindner's operation for fistula of the vitreous had been performed for the relief of acute glaucoma, in ten there developed on the anterior surface of the iris a pigmented ring line similar to the one which Šafář, Guist and Reese had seen after perforating injury in the posterior segment of the eye. After Lindner's operation, acute hypotony sets in; the iris sinks back, its ciliary portion leaning against the ciliary body, while the pupillary portion retains its frontal position. Thus, a picture characteristic of severe hypotony develops. The intra-ocular capillaries are paralyzed, and their permeability is greatly increased. The protein content of the aqueous is very high, and the uvea is greatly edematous. Under these circumstances the formation of ring-shaped folds in the iris is understandable. The pigmentation of these folds is, according to Sallmann, the result of abnormal proliferation of the chromatophores under the influence of the hypotony.

P. C. KRONFELD.

Society Transactions

EDITED BY W. L. BENEDICT

GERMAN OPHTHALMOLOGICAL SOCIETY

Fifty-First Annual Meeting, Heidelberg, July 6-8, 1936

DOCENT DR. M. BÜCKLERS, Tübingen, *Reporter*

TRANSLATED BY PERCY FRIDENBERG, M.D., New York

Demonstration Session

Tuesday, July 7, 1936, 3 p. m.

WOLFGANG RIEHM, M.D., Giessen, *Chairman*

(Continued from Page 315)

MILIARY TUBERCULOSIS OF THE EYE. DR. EDUARD WERDENBERG, Davos-Platz.

Among the forms of ocular tuberculosis the clinical picture of which is most definitely established, i. e., the productive forms, one is struck by the frequency of a miliary type—multiple miliary dissemination (*Aussaat*) in the form of a tuberculous vascular disease. It is most frequently noted in the iris and not infrequently in the choroid. In juvenile subjects with miliary tuberculosis of the iris innumerable deposits of protruding tubercles are often found, which in prognostically unfavorable cases have a tendency to conglomeration. In subjects of a more advanced age it is more common to note "bland" tubercles, which are often sunken in the tissue of the iris and have a tendency to heal slowly. This healing depends on, and is associated with, the blood supply. In the choroid, in addition to acute miliary tuberculosis one not infrequently sees fresh miliary and submiliary lesions. In cases of choroiditis disseminata in which the condition has run its course one occasionally sees areas of healed miliary lesions. Choroiditis disseminata is also seen as a sequela of a fresh miliary seeding, so that the condition may be considered to be mostly a hematogenous dissemination, which is often originally a miliary dissemination, with secondary atrophic-cicatricial changes in the tissue.

THE DISEASE SOURCE OF OCULAR TUBERCULOSIS. DR. EDUARD WERDENBERG, Davos-Platz.

Two interesting facts are discussed on the basis of demonstration material: (1) the decidedly marked parallelism between tuberculous lesions of the eye and those of the thorax, definitely expressed (*a*) as a coarse miliary dissemination in the iris and in the lung and (*b*) as a fine miliary dissemination in the choroid and in the lung, and (2) the

presence of an ascending infection from tuberculous hilus glands in cases of ocular tuberculosis. The most important point to note is that mild and severe (roentgenographically) forms of this mediastinal localization may give rise to equally malignant ocular tuberculous lesions. Because of an apparent, but actually nonexistent, antagonism, the ophthalmologist may be led astray by the estimate of the internist, who bases his judgment only on the inadequate roentgenographic aspect. The presence of malignant tuberculous iridocyclitis was demonstrated in a case of tuberculous tumor of the hilus glands and in a case of slight tuberculous involvement of the thorax, as shown roentgenographically. An ascending intrathoracic infection from the hilus glands, with a parasternal roentgenographic shadow, was demonstrated in a case of severe tuberculous iridocyclitis. Simultaneous with the disappearance of the shadow, that is, with the cure of the source of the infection, the iridocyclitis healed. Often a roentgenogram fails to reveal the disease source, and one must infer, in the presence of a malignant intraocular process, that a similarly malignant tuberculous condition is pathogenically active elsewhere.

THE NORMAL AND PATHOLOGIC PICTURE OF THE INTERIOR APPARATUS OF THE EPITHELIAL CELL. PROF. WILHELM GRÜTER, Marburg.

A number of pictures and original photomicrographs of Golgi's reticular apparatus, both normal and pathologic were shown, beginning with a picture of the normal corneal epithelium after staining with osmic acid by the method of Kopsch-Kolatschew and Nassonow. In the netlike three-dimensional apparatus the deeply stained black centrosomes stand out conspicuously in the end zone of the nuclear poles. In other pictures are demonstrated the inflammatory reaction of this delicate intercellular network to (1) diphtheria toxin, (2) staphylococcus toxin, (3) oil of mustard and (4) herpes virus. The reaction is apparent in the form of a swelling (*Bläehung*) and progressive densification of the Golgi apparatus, which surrounds the nuclear zone like a wreath, and by inflammatory swelling and division of the centrosomes. What is particularly striking is the marked cell division of the spherical Golgi structures about both poles of the nuclei, large caps (*Hauben*) composed of many individual spheres being formed. In them one notes the Golgi bodies, conspicuous because of the intense black stain, which have increased greatly in number or are in the process of cell division. The same deep stain shows clearly that the Golgi framework in the region of the peripheral cytoplasm has formed many new foci and divisions in the three-dimensional framework zone, with similar changes in the included Golgi corpuscles.

REIMPLANTATION OF THE SUPERIOR OBLIQUE MUSCLE TO SERVE AS AN ADDUCTOR MUSCLE. PROF. W. WEGNER, Freiburg.

In 2 children with unilateral oculomotor paresis the cosmetic correction of the position of the eye was attempted by combining tenotomy of the abducens muscle with advancement and displacement of the superior oblique muscle and its attachment to the insertion of the internal rectus muscle. The procedure was carried out through the upper lid. The tendon of the superior oblique muscle was separated from its

insertion, lifted out of the trochlea and carried through Tenon's capsule; the muscle belly was sewed to the insertion of the internal rectus muscle. A satisfactory cosmetic result was attained, with the possibility of a certain amount of inward rotation.

USE OF BUCCAL MUCOUS MEMBRANE IN THE TOTI OPERATION.
DR. GERHARD JANCKE, Giessen.

This procedure is recommended when mucous membrane of the nasal or lacrimal sac is lacking, when the sac is markedly shrunk or when further surgical intervention becomes necessary on account of a relapse following the original Toti operation. Up to the present time healing has occurred in two cases in which operation was performed.

CONTRIBUTION TO THE TEACHING OF OPHTHALMOLOGY. PROF. E. SEIDEL, Jena.

Motion pictures were presented demonstrating the steps of extracapsular extraction of cataract without iridectomy.

OCULOMOTOR DISTURBANCES. DOZENT DR. KARL VELLHAGEN, JUN., Halle.

A miniature film was presented showing an informal collection of the most varied disturbances of ocular motility. Among others, the following conditions were shown: exophoria, esophoria, fixation movements, paralysis of the rectus muscles, primary and secondary angular strabismus, forced positions, ptosis, a pseudo Graefe sign, facial paralysis, Bell's phenomenon, fixation paralysis, hysterical blepharospasm, nystagmus associated with amblyopia and amaurosis and good and bad mobility of artificial eyes. Visual disturbances and their correct and incorrect neutralization are to be shown in a forthcoming film.

TREATMENT OF THE EYE WITH ULTRAVIOLET RAYS. W. GUTSCH, Berlin.

Two hundred and seventy-six patients with ocular disease were treated with the ultraviolet rays in the course of a year. No results were noted in cases of corneal disease, but the good effects were unmistakable in cases of chronic iridocyclitis of the sluggish, progressive postoperative form, in cases of chronic iridocyclitis in which the cause was obscure and particularly in cases of tuberculous iridocyclitis. The precipitates decreased, the opacities of the vitreous cleared and the eye became free from irritation. Healing occurred in a short time in several cases of conglomerate tubercle nodules of the iris and of choroidal tuberculosis, so that one is inclined to believe that the ultraviolet rays have a specific action on inflammatory tuberculous processes in the eye. Retinal hemorrhages are absorbed rapidly without leaving any disturbance of retinal function in their wake. During the flooding of the eye with these rays, the retinal vessels become dilated. In 80 cases of retinal and choroidal disease treatment with the ultraviolet rays brought about rapid healing of fresh inflammatory foci and subjective and objective improvement in retinal function impaired by chronic degenera-

tive processes. Surprisingly rapid recession of purulent inflammation of the orbit and of the lacrimal sac was also noted. The treatment was without effect in cases of glaucoma or of scleral disease, but good results were obtained in cases of paralysis of the external ocular muscles and of supraorbital neuralgia. The tube type of apparatus is better than the spark gap apparatus, as the former permits of treatment with a free interspace of air (*Luftabstand*) between the electrodes at a distance from the eyeball of from about 1 to 3 cm.

DISCUSSION

PROF. KARL VOM HOFE, Greifswald: In cases in which as a rule healing occurs without ultraviolet irradiation, one should be careful in using agents of this type, the action of which up to now has not been sufficiently studied experimentally. I wish to call attention to the lesions (*Spätschädigungen*) caused by the roentgen rays, which were not discovered until many years later. Wetzel's studies show that one has to deal with a considerable heating of the vitreous, a reaction which may well account for the dilatation and hyperemia of the retinal vessels observed by the previous speaker.

PROFESSOR ERGGELET, Göttingen: Krause reported early this year at a meeting in Hamburg, on the results obtained at the Göttingen Clinic with the high frequency method of Schliephake. Without wishing to arouse exaggerated hopes, I want to call attention to the excellent and striking results obtained with this treatment in cases of septic thrombophlebitis of the orbit and of phlegmon of the lacrimal sac. The treatment was without effect in cases of sympathetic ophthalmia and of late infection following operation for a cataract.

PROF. W. WEGNER, Freiburg: In not a few cases chronic relapsing iridocyclitis is associated with papillitis. It is my experience that the course in such cases is particularly chronic and not easily influenced therapeutically. I have used short wave therapy in a rather large number of cases, but up to the present time I have not been able to see convincing results. On the other hand, a parapapillary hemorrhage occurred in 1 case. On the basis of this occurrence, I must advise the greatest possible caution in the use of this treatment. Under certain conditions hemorrhage might take place, e. g., in the macular region, which would seriously impair vision. The gist of the procedure is the production of marked hyperemia, which, if it involves an already diseased vascular system, may easily reach a point at which hemorrhages are inevitable.

PROF. M. BAURMANN, Karlsruhe: Professor vom Hofe need not worry about possible damage by the ultraviolet rays analogous to that caused by the roentgen rays, as the effect of the former consists solely in the production of warmth. Any mysterious effects beyond that do not exist. The ultraviolet rays allow one to produce a heat effect on the intraocular tissues such as one often strives for but never obtains with external hot applications and poultices.

PROFESSOR COMBERG, Rostock: Before diathermy or short wave therapy is adopted generally by the practitioner for the treatment of intraocular diseases, preliminary studies are essential to determine what doses can be tolerated by the vitreous without heating it to a dangerous

degree. The vitreous, the lens, the anterior and posterior chamber and the cornea are structures or/and regions in which no blood vessels are present and in which, accordingly, there is no means of diffusing heat as effectively as in other parts of the body. Hence in these tissues there must be a greater degree of heating than in vascular structures after treatment with the ultraviolet rays as well as with diathermy. If the temperature in the vitreous exceeds the degree of toleration, the most serious damage is caused at once. The necessary experimental studies can easily be carried out.

W. GUTSCH, Berlin: In answer to Professor Wegner, the apparatus used up to now at Höchenschwand was not of the tube type used and recommended by me. The biologic effects of this apparatus are quite different from those noted when the *Funkenstruckenapparat* is used. In answer to Professor Comberg's criticism, so far technical science has not succeeded in constructing an instrument which will enable one to measure accurately and beyond cavil the temperature in a condensation field.

Fourth Scientific Session

Wednesday, July 8, 1936, 8: 30 a. m.

DR. BRONS, Dortmund

MEASUREMENTS OF PRESSURE IN THE CENTRAL RETINAL ARTERY IN CASES OF INCREASED INTRACRANIAL TENSION. PROF. M. BAURMANN, Karlsruhe.

One hundred and fifty cases of increased intracranial tension were studied, and the results were tabulated according to age and to pressure in the brain, the retinal arterial tension being expressed in terms of percentage of the corresponding blood pressure in the brachial artery. The figures of a table of averages and the data of a graphic survey of all the individual cases show that there is only an inconstant and loose relation between the two vascular reactions mentioned in the title of the paper. However a similar arrangement of the absolute values for the pressure in the central and the brachial artery in relation to those for intracranial tension shows that the pressure in these arteries rises in sympathy with the intracranial tension. A method was sought to determine the efficiency of the carotid artery, knowledge of which would be of practical value in case ligation of that vessel was contemplated. With manual compression of the carotid artery, pressure in the central retinal artery of the same side falls (diastolic and systolic) at first and then tends to rise and reach the original level. The systolic pressure hardly ever reaches this point, but the diastolic pressure does. On the side opposite the compression there is no fall in pressure but, on the contrary, a rise (in the central retinal artery). This often exceeds that noted simultaneously in the brachial artery (pressor reflex) and may be due in part to a compensatory overaction of the carotid artery, which has remained open. Measurements on 21 subjects ranging in age from 7 to 67 years showed that 4 of 5 older subjects had an extraordinarily marked primary fall in pressure, diastolic as well as systolic, on the side of compression, with hardly any subsequent rise. Compared with youthful subjects, this group also showed a less

marked increase in pressure on the side opposite the compressed carotid artery. The curves are interpreted as the expression of only a slight capacity for compensation on the part of the opposite patent carotid artery. If there is a decided fall on the side of compression in spite of a marked increase in the pressure in the opposite carotid artery, it is fair to conclude that there is a relative narrowness of the circle of Willis. When the final drop in the diastolic pressure exceeds 10 mm. of mercury on the side of compression, the subject would be jeopardized by a ligation of the carotid artery. Ligation of the common carotid artery of a girl aged 18 was followed by hemiplegia. Measurement of the pressure of the central retinal artery after the operation showed that there had been a fall of 18 mm. of mercury in the diastolic pressure on the side of ligation. A moderate rise in pressure was noted three weeks after operation, and in another three weeks the pressure had nearly reached normal. The compression test carried out some time later again showed a fall of 15 mm. of mercury in the diastolic pressure, demonstrating, in accordance with the figures cited previously, that such a marked fall in pressure is a contraindication to ligation of the carotid artery.

THERAPEUTIC REDUCTION OF INTRAOCULAR TENSION IN CASES OF
ATROPHY OF THE OPTIC NERVE AND OF RETINITIS PIGMENTOSA.
PROF. HANS LAUBER, Warsaw, Poland.

Professor Baurmann's studies indicate that the diastolic pressure in the retinal veins is equal to the intracranial pressure. Sobański's research in my clinic has developed further the knowledge concerning this relation and has corroborated the foregoing conclusion definitely. Hence in many cases it is unnecessary to do a lumbar puncture to determine whether or not there is an increase in intracranial tension. The latter is not the only factor in the pathogenesis of choked disk. The relation between arterial and venous pressure also plays a part. If the blood pressure is high, papilledema does not take place, in spite of a decided increase in intracranial tension, whereas it develops to a slight degree if there is a low systemic arterial blood pressure.

However, this holds good only for the period of pure papillary stasis and not for the stage in which there are secondary inflammatory changes. A pseudopapilledema may be present when the intraocular tension has been lowered or was low from the start, but this condition is seen as a rule only in eyes with hypotony. These problems cannot be decided on the basis of anatomic histologic studies alone. It is essential for one to take into consideration and analyze the retinal circulatory conditions as well. Recent articles like that of Fischer, on pseudopapilledema, which disregard this important factor, are not of a nature to clear up these questions. A clinical study of retinal and systemic blood pressure by my associates and me in a large series of cases has shown that atrophy of the optic nerve develops in cases of tabes when the general blood pressure is lower; or, expressed otherwise, a decided hypotension is present occasionally, sometimes for long periods, in persons with tabes, and it is during these periods that the atrophy appears and progresses. The oculist may be consulted by the patient at a time when his systemic blood pressure is about normal, or even slightly above, but if he is kept under continuous observation for

some time it will be evident that progress of the atrophy in the optic nerve coincides with a fall in the blood pressure. With a return of the blood pressure to normal the atrophic process in the optic nerve comes to a standstill, but it reappears if the pressure falls again. It has been demonstrated that the administration of a number of therapeutic agents, such as arsphenamine, preparations of mercury and of bismuth and iodides, and at times malaria treatment, have a deleterious influence on the blood pressure reducing it and thus causing a catastrophic change for the worse in the process in the optic nerve. This explains the sad fact, fairly well known to all clinicians, that specific treatment of tabes has only an unfavorable influence on the condition of the optic nerve. The atrophy is not directly due to the toxins of the spirochetes, as in that case it would have to appear at a time when the specific organisms are most plentiful in the tissues, viscera and circulation, i. e., when secondary syphilis is present, and not when they have been markedly diminished and when, as is known, the Wassermann reaction of the blood and spinal fluid may have become negative. In this event, there is no protection against the occurrence of atrophy of the optic nerve. In cases of tabes in which there is hypotension, which is often due to a cardiovascular disturbance, such as changes in the walls, dilatation of the aorta or syphilitic myocardial degeneration, atrophy of the optic nerve becomes noticeable and progressive. It is logical to try to raise the blood pressure or, on the other hand, to lower intraocular tension in order to reestablish the normal relations between this factor and the diastolic blood pressure in the retinal vessels. We were able to bring the pathologic process to a standstill and in many cases to ensure considerable and long-continued improvement when we were able to lower the intraocular tension by the use of miotics or, these failing, by operation, generally cyclodialysis, and at the same time to improve the general condition of the patient by the administration of strychnine and of various glandular preparations and the institution of specific treatment. Therapeutic failure was due, generally, to inability to lower the intraocular tension or to the fact that the case with which we were dealing was not one of tabetic atrophy but one of dementia paralytica or of severe vascular disease. Good results like those obtained in cases of tabetic atrophy were obtained in 2 cases of Leber's retrobulbar neuritis of long standing. Both patients, brothers, showed marked lowering of the blood pressure. As there is often a marked disproportion between intraocular tension and diastolic arterial pressure in cases of retinitis pigmentosa, we used the same treatment. Of course, we did not expect to cure the disease itself, the pathogenesis of which is still unknown, but we hoped to improve the circulatory conditions in the retina, as sympathectomy has done according to a number of authors. Up to the present time 21 eyes (12 cases), most of them in far advanced stages of the disease, have been treated. In 14 eyes vision improved, and in more than half of these the visual field, too, became larger. In some cases the improvement has already lasted more than half a year. In 5 eyes the condition has remained unchanged, after improvement for a time in 1 eye. In 2 eyes this temporary improvement was followed by a change for the worse, with recurrence of intraocular hypertension. It is to be expected that the improvement in sight, and in many cases in the visual field, will not be lasting and that the degeneration of the

retina will progress in spite of the temporary improvement in the circulation, as only one pathogenic factor has been affected and the basic cause could not be influenced. Still, even a temporary improvement is in the patient's interest and is worth while. In some of their cases in which sympathectomy was performed also; Caeiro, Malbran and Balza found that improvement after operation was followed by a change for the worse, even after several months. Attempts to improve the retinal circulation by local measures are no novelty. I will not go into the details of the isolated attempts of von Friede (1924), Deutschmann (1924), Gilbert (1924) and Lindner (1936), as the important factor of low blood pressure was not taken into consideration.

I would rather call attention to Abadie's recommendation of retrobulbar injections of atropine for the purpose of dilating the retinal vessels, although it was not shown positively that this was accomplished. But even if it is granted that the vessels actually do dilate after the injection of atropine, it does not follow that there is necessarily a better blood supply (*Durchblutung*) in consequence, as there may be, synchronous with the dilation, a slowing of the blood current, so that the final effect is not definitely secured. The low systemic blood pressure prevents the flow of blood through the dilated vessels with sufficient rapidity to bring to the tissues the copious amount of necessary oxygen.

But as injections of atropine, as we have demonstrated, increase the intraocular tension, they introduce a factor which is highly deleterious for the effective blood supply to the tissues, and this explains the failure of this therapeutic procedure in so many cases. To sum up, as a preliminary to any specific antisyphilitic treatment, the systemic blood pressure, and if possible the local retinal blood pressure in relation to intraocular tension, should be determined and checked from time to time. If one can prevent a lowering of blood pressure, one can hold off the atrophy of the optic nerve. This is a fact of practical importance not only for the oculist but for all physicians treating syphilis. Specific treatment in the presence of atrophy of the optic nerve is permissible only when the necessary stress (*Spannung*) has been established between intraocular tension and diastolic pressure in the retinal arteries. It is then not only harmless but definitely beneficial to the patient. The therapeutic production and maintenance of the aforementioned stress is to be striven for in all cases in which it is lowered. Not all cases of atrophy of the optic nerve are suited to this treatment, as the required conditions mentioned previously are lacking. One must individualize. A skeptical attitude toward these data is expected, but considering their great practical importance it is to be hoped many colleagues will check up these findings and procedures impartially, with careful consideration of the basic idea. The possibility of combating a widespread source of blindness and thus lowering the number of the blind not only presents a grave medical problem but is invaluable from the social-economic standpoint.

MEASUREMENT OF BLOOD PRESSURE IN THE RETINAL VESSELS; POSSIBLE SOURCES OF ERROR. PROF. HANS LAUBER, Warsaw, Poland.

Observers disagree as to the figures for the physiologic norm for the blood pressure in the retinal vessels. This depends partly on the

clinical material used in the research. Duverger and Barré, for example, used mainly sick subjects, so that their findings cannot serve as a criterion for average physiologic conditions. Even Bailliart has given different figures at one time or another, but he finally held to rather low values: diastolic retinal arterial pressure, from 30 to 35 mm. of mercury; systolic pressure, 65 to 70 mm. of mercury. The relation to the pressure in the brachial artery is as 40:100 (Bailliart and Magitot). In youthful subjects with high blood pressure within the physiologic limits (70 mm. of mercury in the brachial artery) this would represent a retinal blood pressure of 28 mm., which would be insufficient for the blood supply of the retinal tissues. Sukanuma's figures, which are higher than those of Bailliart, show that the systemic pressure is strikingly low. This may be a racial peculiarity of the Japanese. Bliedung, too, gives higher figures, but he used a completely different method for the determination. For subjects up to 50 years of age, Sobański gives the diastolic pressure as 40 mm. of mercury and the systolic pressure as 68 mm. For those over 50, the figures are from 48 to 56 mm. and from 80 to 90 mm. of mercury respectively, in the retinal vessels. The result of the study depends largely on the decision as to what moment the diastolic phase begins. According to the internist, diastolic pressure should be measured when there is a definite change in the caliber of the vessel; the systolic pressure should be measured when there is complete interruption of the blood current. This is advisable and justified practically as well as theoretically. The diastolic arterial pressure is the more important in retinal conditions. There is normally a difference of over 20 mm. of mercury between the diastolic arterial pressure and the intraocular tension. If this spread between the two pressure levels diminishes, the circulation in the retinal capillaries suffers. This first affects the conductivity of the fibers and finally causes their atrophy. It is immaterial whether this is due to increased intraocular tension, as in cases of glaucoma, or to lowering of blood pressure, as in cases of atrophy of the optic nerve and of retinitis pigmentosa.

HEIGHT OF BLOOD PRESSURE IN THE CHOROIDAL VESSELS OF MAN: DEMONSTRATION. PROF. E. SEIDEL, Jena.

In albinotic eyes the blood pressure in the vorticose veins can be measured easily by the well known and simple method applied to the retinal vessels. The slightest pressure on the eyeball, which, as is well known, brings about immediately a collapse of the retinal veins of the disk, is seen to be accompanied by a narrowing of the sinuses of the vorticose veins. This proves that the slightly increased intraocular tension is sufficient to embarrass the circulation in the vorticose veins or, in other words, that this tension already exceeds the blood pressure normally present in these veins. This phenomenon is particularly striking in albinotic subjects who present in addition to the usual 4 large vorticose veins a number of smaller ones (up to 6), which also emerge from the eyeball at the equator. These collapse completely when the slightest pressure is exerted on the eyeball, acting in this respect exactly like the veins of the papilla. This proves that the pressure is the same in the retinal veins and in the vorticose veins and only slightly higher than the intraocular tension. Combined measurements with the tonometer and the dynamometer show that even so slight an increase

in tension as 5 mm. of mercury is sufficient to overcome this pressure and cause a collapse of the smaller vorticose veins, which have about the same caliber as the veins of the disk. These phenomena were demonstrated in an albinotic subject aged 16. A number of important conclusions are drawn concerning the physiologic significance of this venous pressure. For one thing, under normal conditions replacement of the aqueous cannot be brought about by physical filtration (Leber) but is caused only by vital cell activity, i. e., primary secretion.

HISTOPATHOLOGIC PICTURE OF THE EYE IN ASSOCIATION WITH
CHANGES IN THE KIDNEYS AND IN THE BLOOD PRESSURE. PROF.
HUGO GASTEIGER, Frankfort on the Main.

The many varying views as to the pathogenesis of so-called albuminuric retinitis were the occasion for a study of 6 patients with this condition. The clinical diagnoses were chronic interstitial nephritis (*maligne Nephrosklerose*), chronic nephritis and in 1 case hydro-nephrosis, with subsequent nephritis and a fatal termination due to uremia. The ages of the patients were between 17 and 38. Fatty degeneration of the arterioles of the optic nerve and of the retinal vessels was found. There were accumulations of lipoids in the region of the posterior pole, and in 1 case these accumulations were also found in the periphery. They were most abundant in the internuclear layer and the nerve fiber layer, although scattered drops could be found in other layers, and accumulations were observed here and there in Müller's supporting fibers. The fat corpuscle cells were undoubtedly of glial origin for the greater part. Between the pigment epithelium and the retinal layers, leukocytes which had wandered in from the choroid were found in a state of fatty degeneration. Doubly refracting fats were found here and there and also varicose hypertrophy of the nerve fibers, edema, fiber basket (*Faserkorb*) formations and hemorrhages. The pigment layer showed no pathologic changes of note. Fat was demonstrated by the sudan stain only in the neighborhood of the disk in some eyes and there was some formation of warty nodules in this area and in the lamina vitrea. In the choroid fat was found in the vessel walls and in the stroma. Mainly in the region of the posterior pole but also in the periphery, the vessels showed a high degree of thickening of the walls, partly due to proliferation of the intima but principally to thickening of the muscular coat. Similar changes were found in the vessels of the ciliary body and processes. In the iris they had led in some places to complete occlusion of a vessel. The pathologic process was identical with that found in the small vessels of the kidney. Finally, in 1 case the sudan stain showed the presence of fat in Descemet's and in Bowman's membrane, in the corneal lamellae and in the leukocytes in the neighborhood of the limbus. There was no evidence of any external disease of the eye. The changes were undoubtedly connected with the underlying condition and due to a disturbance of circulation. When changes take place in blood pressure and in the kidney, the entire circulatory system of the eye suffers accordingly. At first the impairment is only functional; changes in the vessels cannot be demonstrated histologically until later. But even in the early stages, retinal lesions can be found. The predisposition of this structure, and especially of the macula, to pathologic changes under these conditions

is best explained, as Schieck has done, by the discrepancy between a comparatively meager blood supply and a high nutritional demand. Inflammatory changes play only a minor role in the disease picture, certainly not a decisive one. Koyanagi's well known view is not supported by these findings. There is no causal relation between retinal and choroidal lesions. They are associated results of a common pathogenic factor.

DISCUSSION ON PAPERS BY PROFESSORS BAURMANN, LAUBER,
SEIDEL AND GASTEIGER

DR. ARRUGA, Barcelona, Spain: Although one is necessarily skeptical about all therapeutic suggestions for atrophy of the optic nerves, I treat my patients according to Professor Lauber's method because I consider it harmless and also because I was impressed by the unfavorable clinical course in cases of glaucoma simplex in which the blood pressure was low. All patients with atrophy of the optic nerve have low blood pressure, and the results of treatment are good if one can raise it and/or lower intraocular tension. The first factor is the more effective, although at times difficult to establish. In addition, I have used pilocarpine locally, performed cyclodialysis and prescribed good nourishment, tonics, strychnine, atropine, an ephedrine preparation, sun baths, mountain climate and travel. Persons with nontabetic atrophy were not benefited; however, all had normal or high blood pressure before treatment.

PROF. H. LAUBER, Warsaw, Poland: My associates and I laid great weight on early surgical intervention on account of the peculiarity of our clinical material. We could not keep the patients under treatment as long as was necessary for any material influencing of the circulatory condition. Accordingly, the intraocular tension was chosen as the point to attack. Retrobulbar injections of atropine may dilate the retinal vessels, but as they also raise the intraocular tension the good effect is neutralized, to say the least. The hematic nutrition of the retina certainly cannot be improved by this means.

PROF. E. SEIDEL, Jena: I have been misunderstood. I no longer measure blood pressure in the so-called abnormal, or posterior, vorticose veins which go through the sclera between the disk and the macula. My communication was based on observations on the vorticose veins proper, which enter the sclera from the choroid, close behind the equator, as from four to six larger vessels, accompanied by a varying number, generally from one to six, smaller ones (Leber and Fuchs). As mentioned previously, both sets of veins, like the central retinal vein, collapse completely on minimal digital pressure on the eyeball and are quite empty of blood, so that the pressure in these vessels can be only a few millimeters of mercury higher than the intraocular tension. The absolute height of the blood pressure in the retinal arteries will play an important role in the future (Lauber). I have repeatedly called attention to the fact that this figure (both for diastolic and for systolic pressure in the retinal arteries) depends greatly on the speed with which intraocular tension is raised by compression. This immediately explains the discrepancy in the values obtained by various writers for normal subjects with the procedure of Bailliart. The immediate effect of digital compression on the eyeball is to obstruct the flow of blood in the central retinal artery until the blood pressure in that vessel may be raised almost to the

level of that in the ophthalmic artery at the point where the central retinal artery leaves it. A vessel 2 mm. in diameter has a blood pressure approximately equal to the systemic blood pressure (*Poiseuille*). This stasis-error can be eliminated, or rather reduced to its lowest possible minimum, only by a rapid increase in the compressive force. With a slow increase one always obtains figures which are decidedly too high. This holds good for the diastolic pressure which is present at the moment of the first large pulsation as well as at the time of complete collapse of the vessel. It also applies to the systolic pressure, which is reached when the compression is attained which keeps the vascular tube free from blood, not constantly but only during several cardiac periods. The only correct figures are the lowest which can be obtained after careful training and long experience with this method. In a case in which the general blood pressure was 120 mm. of mercury I obtained exactly the same values as Bailliart, that is, for the diastolic pressure 35 mm. of mercury and for the systolic pressure values of from 55 to 60 mm. of mercury, when I (as was done by Bailliart before he made use of the gage curve mentioned by Baurmann, planned from observations on the eyes of cats) subsequently measured with the dynamometer and the Schiötz tonometer, using Schiötz' gage curve II, the intraocular tension which had been artificially induced by compression.

HYALINE DEGENERATION OF THE LAMINA VITREA. DR. WALTHER REICHLING, Berlin.

Only definite hyaline structures were considered in this study. In some cases they were so numerous that one might speak of a miliary hyalinosis of the lamina vitrea. In many microscopic sections from 200 to 300 drusen of varying dimensions were counted. Between these nodules the entire lamina vitrea had undergone hyaline degeneration, with a smooth surface. Similar hyaline degeneration was found in the membrana elastica interna of larger choroidal vessels, corresponding in morphologic structure and staining qualities to senile drusen. This is actually an arteriolar sclerosis. The basal lamina in the choriocapillaris also showed hyaline changes. All this demonstrates clearly that drusen are not an isolated disease of the lamina vitrea but part of a degenerative process affecting the entire system of limiting membranes between the choroid and the retina. In many cases these lesions cause no appreciable clinical symptoms, but the pathogenic factor may be of importance, as hyaline changes are noted in eyeballs affected by such different processes as phthisis bulbi and secondary glaucoma.

DISCUSSION

DOCENT DR. MAX BÜCKLERS, Tübingen: Dr. Reichling drew conclusions as to differences in the histologic structure of drusen from their reaction to Mallory's stain. For twelve years I have been using Heidenhain's azan stain, which is an improvement on the Mallory stain, and have been able by means of it to see the beautiful colors, ranging from violet and blue to red, in the cortex of the lens. However, a warning should be sounded against drawing too far reaching conclusions as to histologic and, above all, physicochemical composition from such varying reactions to staining methods. Von Möllendorff's studies have shown that the histologic staining process is an exceedingly complicated

one and that a number of different factors are involved. Hence one cannot draw conclusions as to the identity of a composition on the basis of similar staining reactions or, on the other hand, on the basis of dissimilar staining reactions.

DR. WALTHER REICHLING, Berlin: I agree that the result of Mallory staining should be interpreted with caution, but my conclusions were based also on other data in regard to form and structure of the lesions.

NATURE OF THE PROWAZEK BODIES AND OTHER INCLUSION BODIES. PROF. WILHELM GRÜTER, Marburg.

The nature of such bodies, e. g., the structures found in cases of bacteria-free blenorrhoea neonatorum, is still obscure. Experience gained in the study of inanimate cell poisons with varied staining methods, including osmic acid, were put to appropriate use in this research. Vaccinia keratitis in the rabbit presents a particularly well defined picture of focal inflammation of the Golgi system. This appears at both poles of the nucleus as a three-dimensional structure, with a Golgi body in a corresponding stage of cell division, there being one or more structures larger than cocci, and stains deeply black with osmic acid. A similar picture is presented by herpetic keratitis in the rabbit, but here the acute inflammatory reaction of the corneal epithelium induces an unusually intense swelling (*Blaehung*) and proliferation of the entire Golgi framework. The little Golgi bodies, although they have multiplied greatly, can hardly be seen, as they are hidden in the fine meshes of the densely proliferating network of the whole Golgi zone. Dark field examination of the hanging drop culture shows that the deeply stained corpuscles are actually glass clear, round or oval, homogeneous vacuoles, which glitter in the light of the dark field. They have a definite fine polar formation in the form of minute secondary superimposed vesicles. These secondary vacuoles are cast off later, and the primary forms break down also. The vacuoles, either singly or in moruloid formation, appear in lesions produced by animate and inanimate cell poisons, staphylococcus toxin, diphtheria toxin and oil of mustard. The specimens studied were checked repeatedly as to freedom from bacteria. The Prowazek bodies of trachoma are simply the spherical Golgi bodies which have increased in size by cell division under the stimulus of inflammation. In the entire course of the trachomatous process no structures were found which in any way suggested parasitic organisms, nor were there any unusual inclusion products of inflammation, such as the hypothetical chlamydozoan (Prowazek), either in the nucleus or in the cytoplasm.

DISCUSSION

PROF. KARL LINDNER, Vienna: Conclusions as to the nature of trachoma bodies are possible only if these structures are studied in all their phases, either in a fresh moist smear or in sections. In a dried smear the inclusion body is like a shriveled jelly fish which gives no inkling of its actual original form. The analogy advanced by Grüter is incorrect. In America Thygeson has published a series of articles dealing with the inclusion virus which in every respect confirm my own findings. This investigation started from the observation of inclusion-bodies in cases of psittacosis which are morphologically almost identical with the free initial bodies of trachoma.

PROF. H. HERZOG, Berlin: It is an open question whether the cell inclusion bodies described by Grüter correspond to the inner network (*Binnennetz*) of Golgi. But it is impossible to subscribe to his interpretation that the essential and basic histologic factor in the pathogenesis of trachoma is presented by the structures which he found in the cytoplasm. At all events, it is necessary to oppose energetically the misunderstanding which has arisen in this connection. Since Prowazek's observations the essential factor has not been considered the so-called trachoma bodies in any case but rather the individual corpuscular elements which composed them, i. e., the elementary organisms of varying size, down to the ultramicroscopic (*subvisiblen*), which are found scattered singly or in twos in the epithelial cell or enclosed in larger zooglea-like groupings. It is out of the question that any of the original structures found by Prowazek were normal formations, products of biologic metabolism, structures due to secretory functions (*Sekretgranula*) or an expression of the decomposition of ageing or diseased protoplasm. I have been able to produce these inclusion bodies experimentally by inoculation of pure cultures of gonococci into the healthy human conjunctiva of a blind eye which has been voluntarily placed at my disposal. There are many other inclusion bodies, as I have pointed out previously, such as secretion granules, Ballowitz' baskets, idiosomes, mitochondria and trophoplasts, which complicate extraordinarily the problem of trachomatous infection in the epithelial cell. Trachoma is not of a herpes nature. Progress in the study of this problem requires that one take into consideration data of a recent investigation in bacteriology concerning the life cycle of micro-organisms which was based on research into their variability as to morphologic and biologic activity.

PROF. WALTER LOHLEIN, Berlin: I should like to ask Professor Grüter whether he considers the structures made visible so beautifully, particularly in the dark field, and which without prejudice and provisionally he has called "vacuoles," to be the cause of disease or animate structures at all. Does he assume that these vacuoles, in which he speaks of budding (*Sprossung*) and reduplication (*Vierteilung*), actually have a structure, which I have so far been unable to detect, or does he, perhaps, infer that they are formations called into being by an exceedingly minute self-contained activating body (*Erreger*)?

PROF. WILHELM GRÜTER, Marburg: The Golgi vacuoles described by me are identical with Lindner's initial corpuscles, but I cannot say whether they are the actual carriers of trachoma. In the dark field they are uniformly homogeneous. A finer inner structure different from the minute secondary changes at the poles (*Polungen*) could not be made out. After these structures have been allowed to develop for several days in the inflamed epithelial cell, they are generally larger than cocci and so cannot be the pathogenic factor of trachoma, which at the present time is generally assumed to be a filtrable virus.

CHANGES IN THE NERVE STRUCTURES OF THE CORNEA AFTER EXTIRPATION OF THE GASSERIAN GANGLION. K. A. REISER, Bonn.

About thirty hours after extirpation of the gasserian ganglion the first signs of degeneration of the corneal nerves appear. After sixty

hours hardly a single fiber of the thick corneal nerve bundles is intact. Some nerve fibers have coalesced to clumpy strands, in which more or less numerous vacuoles are seen, depending on the degree of degeneration. Other fibers break down into rows of fine granules or into segments. The signs of degeneration lessen gradually toward the periphery of the nerve elements. In so-called preterminal network there is only a delicate thickening of the nerve fibers. The terminal reticulum shows no signs whatever of degeneration. This power of resistance is due to the syncytial structure and has been known for some time. The few fibers which enter the cornea from the conjunctiva suffice to provide the nerve supply to the corneal cells by way of the terminal reticulum, which has remained intact after section of the afferent nerves. These histologic data also explain why after radical extirpation of the gasserian ganglion, as opposed to injection of alcohol, neuroparalytic keratitis rarely ensues.

DISCUSSION

PROFESSOR ENGELKING, Heidelberg: I should like to know about the extent of Reiser's experimental material and whether his results were uniform.

K. A. REISER, Bonn: Fifteen eyes were examined. Involvement of the trigeminal nerve is probably not responsible for neuroparalytic keratitis. This condition does not occur after destruction of the nuclear region (*Kerngebiet*) of the trigeminal nerve and can, accordingly, be caused only by nerve filaments which join this nerve in its course and which when pathologically altered in any way bring on a corneal inflammation.

RETINAL DETACHMENT. PROF. W. MEISNER, Cologne.

The relative frequency of retinal detachment in cases of myopia, on the one hand, and in cases of emmetropia and of hyperopia, on the other hand, is considered. In the latter, the frequency does not rise markedly until after the patient is in the fifties. At an earlier age it is almost always possible to detect pathologic changes in the vitreous, retina or uveal tract. Since detachment in cases of myopia of low degree is seen predominantly in elderly persons and since high degrees of myopia are decidedly less numerous than the lower degrees, the increasing hazard associated with the advance of myopia becomes apparent.

TRUE RETINAL CYSTS AND RETINAL DETACHMENTS. DR. ERNST CUSTODIS, Düsseldorf.

In a patient aged 30 there were grouped about the disk, about half way to the ora serrata, five large cysts, of from 3 to 5 papilla diameters, and on the temporal side, somewhat nearer the ora serrata, two smaller cysts, of from 2 to 3 papilla diameters. There were no cysts below the disk but a somewhat more protruding detachment. The Gullstrand instrument showed that these cysts were located in the middle, inner nuclear and outer plexiform layers of the retina, dividing it into two layers and protruding into the vitreous and also toward and against the wall of the globe. No tears were detected. Histologic examination con-

firmed the clinical findings, except for the fact that some small cysts had been overlooked. The content of the cysts was generally clear. Smaller ones contained markedly hypertrophic Müller supporting fibers. The wall of the cyst showed a marked disappearance of cells and complete absence of sensory elements. There were defects in the external limiting membrane. The pathologic changes were probably connected with the nutrition of the retina. As a cause of pathologic changes in the supporting tissue of the retina, clinical experience has indicated vascular disturbances, blunt injury and detachment. In some cases there may be a congenital inferiority, structural or biologic, of the glial substance. This need not affect the entire retina. That it may be present only in certain limited regions is proved by the observation of tears at the ora serrata and the formation of cysts in cases of detachment below and outward in juvenile subjects.

RETINAL DETACHMENT AND TRAUMA. · PROF. E. KRÜCKMANN, Berlin.

Injuries acting indirectly to produce retinal detachment if the following triad is present are discussed: (1) abdominal pressure; (2) congestion, cerebral and intraocular, and (3) a swelling in the retina similar to that in the brain. A porter stated that when the sack he was carrying suddenly slipped he became frightened and clutched the sac, holding it with one arm while he tried to lift it up with the other arm. The retina was torn loose at the end of the ora serrata. The explanation for the detachment was sought in the sudden and intensive action of the inferior oblique muscle associated with the quick upward glance while the patient was in a crouching position. The inferior oblique muscle exerted a suction action on the sclera, which had been made tense by retinal swelling, conceived as a swelling in the brain in this case, and caused the retina to tear loose at its anterior end. A number of other conditions are considered which could lead to tears at the ora serrata.

DISCUSSION ON PAPERS BY PROFESSOR MEISNER, DR. CUSTODIS AND PROFESSOR KRÜCKMANN

PROF. WALTER LÖHLEIN, Berlin: Such clinical surveys of a large amount of material are valuable and enable one to eliminate a number of factors of error. There appears to be no uniform single cause for retinal detachment, even if one considers only the myopic form. An etiologic and genetic subdivision will give data for or against the choice of this or that operative procedure. Professor Meisner's figures confirm the impression that a moderate degree of myopia presents as great a hazard for detachment as a high degree. Possibly in the cases of myopia of extreme degree degenerative changes in the fundus are unusually extensive, causing wide areas of scar fixation which tend to counteract detachment.

PROF. KARL LINDNER, Vienna: It is the rapid snatching motion of the eye which causes the tear, but the direct effect is due to the vitreous, which has become detached. Like all elastic bodies, it stretches to the limit and then snaps back. The stretching is due to the lag of the vitreous masses based on inertia of sudden movements of the eyeball.

This is the mechanism of shock to the vitreous body which may cause the degenerated retina to tear, particularly at exposed points of attachment of the vitreous. Such shock generally affects the upper half of the retina when the eye instinctively and suddenly glances upward. The flap tear then remains attached to the separated vitreous. One must admit that the injury is the exciting cause. Except for it, a detachment might never take place, as the vitreous in the course of years loses mass, and with it dynamic energy, either through shrinkage or as a result of central fluidification. In penetrating injuries, on the other hand, it is hemorrhage into the vitreous which becomes organized and detaches the injured retina and so leads in the course of time to detachment of a small part of the choroid. Intraocular fluid is now absorbed by the choroid; the compensatory replacement of the aqueous causes a further contraction of the rest of the transparent vitreous. The same process is involved in the formation of cystic holes in the macula. Those who attribute the development of a retinal defect to retinal degeneration, pure and simple, should choose some other designation for the term "flap tear."

PROFESSOR BARTELS, Dortmund: I am inclined to believe that the cystic degeneration is often located, at its incipency, in the outer plexiform layer, particularly external to the fiber layer of Henle. There seems to be a contradiction in the fact that tears in the region of the superior oblique muscle are almost always tongue shaped while those in the lower segment are disinsertions at the ora serrata. If the inferior oblique muscle plays a part here, the difference in the form of the tears is not easy to explain. The superior oblique muscle would seem to be the stronger of the two muscles.

PROFESSOR PILLAT, Graz: It would be well to drop figures of the degree of the myopia from consideration in the statistics of detachment and to judge the character of the error of refraction from the standpoint of the presence or absence of degenerative changes. For similar reasons, perforating injuries should be excluded or at least considered separately in statistical studies, in order to lay stress on the effect of contusion. This factor has a particularly dire influence on biologically inferior eyes, and it is in these that it generally causes detachment. The case of a young Mongol is related who was thrown from his saddle, and dragged by the stirrup and whose head was struck repeatedly against the ground. There was a bilateral detachment of the retina with several slit tears, with eventual complete restoration of vision in one eye. In the other eye hemorrhage into the vitreous became organized and led to blindness.

DR. ERNST CUSTODIS, Düsseldorf: As a result of pathologic changes in the glia, the retina loses some of its resistance to mechanical injury and also some of its toughness. Accordingly, in the case under discussion it is possible that the retinal tear and/or disinsertion at the ora serrata were caused by traction on the part of the vitreous, but the tear was made possible only by the fact that disease of the glia caused the retina to tear easily. Repeated examinations have shown me that the vacuoles are found near or in the inner nuclear and outer plexiform layer rather than in the outer nuclear layer.

LIMITS OF NATUROPATHY IN THE TREATMENT OF OCULAR DISEASES.
PROF. KARL VOM HOFE, Greifswald.

The living organism has the faculty of overcoming various diseases without extraneous aid. Nature's method of cure can be aided without medication by the application of natural stimuli. It follows that only those diseases of the eye which are susceptible to spontaneous cure can be safely subjected to these measures. This is generally the case with the majority of acute inflammations of the conjunctiva, iris and choroid. Cure may take some time. There are exceptions enough, especially such ocular pathologic processes as inflammation due to the diplobacillus, *ulcus serpens* and many others. At any rate, acute inflammations of the conjunctiva, which experience has taught heal spontaneously, should generally not be treated with medication the action of which is not sufficiently known and which under certain conditions may do damage or interfere with the healing processes of nature. *Blennorrhoea neonatorum* and *adulorum* are examples. Repeated and copious irrigations do not cause the gonococci to disappear. In fact, they are found in the conjunctival sac after all clinical symptoms have ceased. If the irrigations are kept up during the night, the patient is deprived of sleep, and thus his resistance to infection is impaired. Pus should be gently wiped away from the lid fissure and irrigations should be reduced to the minimum, even in the presence of corneal infiltration. I have used this gentle method for a long time and have not lost a single eye. In cases of scrofulosis (phlyctenular keratitis?) also, all too frequent local medication aggravates the blepharospasm, which is a protective reaction. It can hardly be questioned that climatic and dietary treatment of ocular tuberculosis, especially of the sluggish forms, brings about better results than injections of tuberculin. Chronic inflammatory conditions get well promptly if they are left alone, even the postoperative conditions as well as true hypersensitivity to drugs, which is frequent enough and often overlooked. Patients treated in the clinic for months without success get well promptly when hospitalized. The change in the entire surroundings plays a part, as it does when conditions are reversed. It is always futile to continue with any form of active treatment for months. If it is efficacious, it should act at once. All this implies experience and judgment. The latest handbook of naturopathy, by Brauchle, which is also intended for the educated layman, has a section on the treatment of ocular diseases, including hordeolum, trachoma, interstitial keratitis, herpes zoster (*Gürtelrose*), chalazion, conjunctivitis, *ulcus serpens*, "scrofulous" blepharitis and iritis. The treatment, obviously invariably successful, is practically the same in all cases, viz., steaming the eye with chamomile tea, eye baths, poultices and raw diets. Such measures will not cure a true progressive *ulcus serpens*, and most hordeola and inflammations of the conjunctiva get well without "alternating hot and cold douches, foot baths, sitz baths, raw diet, etc." Diplobacillary conjunctivitis, for instance can be cured more rapidly and cheaply with zinc preparations and staining solutions. For diseases which offer no prospect whatever of recovery, such as embolism of the central retinal artery and retinitis pigmentosa, Brauchle advises visual exercises after the manner of Bates. They do no harm. True, they do no good either. For retinal detachment, Brauchle advises "exercises to lower tension, suggestive therapy." For decades this particular con-

dition has been treated for years at a time and in every possible way without success and has not been affected by general treatment of any kind. Failure to perform a timely operation, which is successful in from 50 to 60 per cent of the cases, is in most cases a grievous error which cannot be rectified, and it is seen, in this condition particularly, how a dogmatically maintained and one-sided point of view may work out to the damage of the patient. Brauchle says that glaucoma may lead to blindness if it is not attacked by "general treatment and a complete change in the entire way of living." He also advises the laying on of hands (on the eyes) and "certain ocular motions (sweeping and swinging, according to Bates). If the attack is acute the body and/or legs are to be wrapped up and baths and a fruit diet prescribed. Much work has been done on glaucoma in the last few years, and any physician who has had much clinical experience with this disease, whether untreated or treated by naturopathy, has learned that glaucoma is never affected spontaneously or by general treatment for any length of time. Unless treated locally, glaucomatous eyes are doomed to blindness. However trivial these remarks may sound, Brauchle's statements make it imperative for one to point out one's own experience openly and frankly and in the interest of the health of the community and to warn most insistently against his way of treating glaucoma. Warts can be cured by suggestion, and so can eczema of the lids at times. Years ago, together with Krantz, I experimented with simulated radiotherapy in cases of chronic eczema of the lids. But to treat glaucoma or retinal detachment suggestively without medication or/and surgical measures would be a grave error. In cases of glaucoma in which systemic indications made it necessary to put the patient on a diet free from meat and salt, I have never been able to see any effect on the increased intraocular tension from such measures alone. The same negative results followed the use of foot baths of all sorts, wet packs and similar measures in cases of simple glaucoma. Scheerer's clinical experience tallies with mine. Natural healing must be avoided and replaced when it does harm.

SPECIFIC OR NATURAL TREATMENT FOR OCULAR TUBERCULOSIS?

PROF. W. WEGNER, Freiburg.

Clinical experience in Höchenschwand Institute in the Black Forest with about 500 patients with ocular tuberculosis, one third of whom had previously had specific treatment, proved that these measures were rarely carried out systematically, persistently or in a way to satisfy the theoretical requirements. Most of the patients had not received more than a few injections of tuberculin, and those rather irregularly. Small doses were the rule. When large doses were given, unmistakable damage resulted in a number of cases, especially after inoculations according to the method of Pondorf. Treatment of an ambulatory patient with tuberculin is absolutely contraindicated, as its results are incalculable. Dietetic treatment at a sanatorium at a moderate altitude (*Mittelgebirge*) makes any and all specific treatment superfluous and offers the best prospects possible in cases of ocular tuberculosis.

IN WHAT WAY CAN NONSPECIFIC STIMULATION THERAPY INFLUENCE ALLERGIC CONDITIONS? DR. PROF. WOLFGANG RIEHM, Giesen.

The purpose of this therapy is to increase the efficacy of certain organic functions concerned in overcoming chronic infections. The

stronger the stimulus, the longer the period of latency which precedes any good effect. In this antecedent phase of aggravation (*Mehrbelastung*) and inhibition of function, however, lies the hazard of this method. The activity of the antibodies is not increased until later, but it is a mistake to judge their effect by the ease or the difficulty with which phenomena of hypersensitivity are produced. These phenomena do not by any means denote an increase in the antibodies. On the contrary, sensitization may increase when there has been a loss of cast-off humoral antibodies which protect the cell from the cellular reaction, i. e., the anaphylactic reaction. If the initial phase of deallergization is provoked too intensely and continued too long, the bacteria take advantage of this by a rapid increase in number and toxicity. The bacterial reaction depends on the degree of allergization, because in so-called bacterial allergy the corresponding antibody fulfils a function which is closely associated with the protective mechanisms of the organism in striving to overcome the pathogenic factor (*Erreger*). As bacterial protein and antibodies are antagonistic, antibodies thrown off and free in the circulation must be dangerous to individual bacteria. The antibodies in an allergic state (antianaphylactogens) are in all probability identical with certain bacteriolysins.

DISCUSSION ON PAPERS BY PROFESSORS VOM HOFE AND WEGNER
AND DR. PROFESSOR RIEHM

DR. REINHARD BRAUN, HABIL., Rostock: Tuberculin treatment of ocular disease must be condemned in toto. In some cases it has done much harm; in others it is justified, particularly in cases of sclerosing keratitis and of scleritis. Focal reaction to the treatment can be seen with the slit lamp, and in a case under observation at this moment I have noted a definite limitation of the process. It is a matter of course that the general condition be kept under the most careful observation by periodical physical examinations, even during the period of treatment. Even after a cure there should be a therapeutic follow-up study for months and years.

PROF. BRUNO FLEISCHER, Erlangen: I have had good results with various tuberculin preparations in the course of many years and especially with tebeptotin (Toenniessen). Great precaution is, of course, essential in the use of all these preparations. I aim to give the smallest amount possible consistent with a positive, even slight reaction. Specific treatment is aided by clinical therapy with fresh air, rest and good nutrition.

PROF. RICHARD SCHEERER, Stuttgart: I consider it of basic importance and absolutely essential that the procedures of naturopathy be objectively and carefully tested by ophthalmologists.

PROF. KARL VOM HOFE, Greifswald: In the last analysis it is nature that cures. One can aid natural processes only when they are present in some form, i. e., in diseases which experience shows often heal of their own accord. There is no such natural cure for glaucoma. Medication and surgical intervention can, however, do away at once with the most dangerous symptom, increased tension, which is the factor leading to blindness in practically all the cases.

(To Be Concluded)

Book Reviews

Eyestrain and Convergence. By N. A. Stutterheim, M.D. Price, 7s. 6d. Pp. 89, with 2 illustrations and 3 tables. London: H. K. Lewis & Co., Ltd., 1937.

In this short monograph the author states that the true primary position of the eyes is one of divergence, the extrinsic muscles acting as tensors and not antagonistically. In his opinion, convergence represents an autonomic power of the mind (or brain), which acts by visual reflexes only and not through volition or with the assistance of consciousness. During vision this convergence keeps the muscles of convergence (all the extrinsic muscles of the eye except the external rectus muscles) in constant action. Convergence acts as much through inhibition of its muscles as through their contractions (Sherrington). The complete development of converging power is necessary for man's visual efficiency in modern civilization. If this power is not fully unfolded, eyestrain results. This eyestrain is curable by kinetic treatment, which is designed to develop the power of convergence.

Stutterheim agrees with Brouwer that Perlia's nucleus is the convergence center and that it exists only in the simians, presimians and felines, the only mammals having a fovea and approximately parallel visual axes. He also states that the highest development of the brain is not ocular function but rather binocular, bifoveal function, the kinetic principle of which is convergence. Fusion is the result rather than the cause of convergence. Just as accommodation is the kinetic part of monocular vision, so is convergence the kinetic portion of binocular vision. If convergence is absent, there is diplopia; if convergence is insufficient, eyestrain, or asthenoconvergence, results.

The author also discusses the innervation of the muscles of the eye and the relations between convergence and accommodation. Because convergence is a phylogenetically young reflex, it is likely to be insufficient.

In testing for asthenoconvergence, the patient sits 5 or 6 meters away from a black screen, which is 4 feet (120 cm.) square. The fixation object is a strip of white cardboard, 75 by 10 mm., which can be rotated to test for both horizontal and vertical convergence. There is a chin rest for the patient and a trial frame for holding single prisms. Successively stronger prisms are placed in front of the eyes until the double images of the white strip no longer fuse; the strongest prism with which fusion is attained is taken as the strength of convergence. The nominal range of convergence is approximately 50 degrees of prism, which is about two and one-half times the convergence used in ordinary reading. Stutterheim thinks that amblyopia, contracted fields and photophobia are uncommon but definite signs of asthenoconvergence and that visual acuity may improve after kinetic treatment.

In treating asthenoconvergence, Stutterheim uses a set of single prisms and two batteries of eight prisms, one ranging from 1 to 8 degrees, base at 180 degrees, and one varying from 0.25 to 2 degrees,

base at 90 degrees (the latter for vertical deviations). He first measures the heterophoria for distance with a Maddox double prism and a red glass before the two eyes and then measures the prism abduction and adduction. If the convergence is less than 50 degrees, it is considered to be insufficient, and convergence exercises with the prisms are given until the highest convergence possible (up to 84 degrees) is attained. If success is not attained with the fixation object at 6 meters, it can be brought nearer the patient. Approximately twenty-four sittings are required to cure asthen convergence, three of them being used for diagnosis.

The final table of the monograph gives the data for the first hundred patients treated by the author (more than a thousand patients have been so treated); all except six of these one hundred were relieved of their symptoms.

This reviewer will not attempt to criticize the author's theory of the action and innervation of the extrinsic muscles of the eye.

With regard to his treatment, it seems to have been very effective in his hands. It is a question whether all persons with convergence insufficiency need such prolonged and drastic exercises. In this country ophthalmologists are interested in measuring the convergence near point and the PcB (punctum convergens basalis); when they are remote, simple convergence exercises which are carried out at home by the patient often relieve symptoms.

Because Stuttenheim has devoted a great deal of time to the study of the extra-ocular muscles and because he has developed a routine treatment for aiding persons with convergence insufficiency, his monograph deserves to be read by those ophthalmologists who are particularly interested in cases of muscle unbalance.

W. F. DUGGAN.

Der psychische Restitutionseffekt. By Otto Löwenstein, M.D., formerly full Professor and Director of the Psychopathological Institute of the University of Bonn, and Directing Physician of the Rhine-Provincial Sanatorium for spiritually abnormal children in Bonn; at present in Nyon, Switzerland, La Métairie Clinic. Price, 8 francs (Swiss). Pp. 92. Basel: Benno Schwabe & Co., 1937.

In a previous publication reviewed by Ward Holden in the ARCHIVES (15:365 [Feb.] 1936), the author discussed the disturbances of the pupillary light reflex in cases of syphilis of the central nervous system and showed how they could be distinguished from nonsyphilitic anomalies of this function. In the present work he devotes himself to an analysis and explanation of the psychically occasioned restitution of fatigued, exhausted or diseased function as it is expressed mainly in the pupillary reaction to light but also in the patellar tendon reflex. The effect of psychic stimulation, pleasant or unpleasant, on fatigued bodies is a well known phenomenon. The author calls attention to the influence of military music on tired marching troops. This has been rather cursorily attributed to a simple inhibition, whereas Löwenstein shows that it is a true phenomenon of defatigation (*Entmüdung*), affecting actual fatigue, and mainly of neurovegetative provenance. The physiologic nature of fatigue brings up problems of chronaxia,

parabiosis and other factors, which the author intends to discuss in a later publication. As shown in his earlier work, mentioned previously, "organic" destruction of the pupillary reflex, as found under pathologic conditions, for instance in many cases of syphilis of the central nervous system, shows a far reaching analogy with physiologic fatigue. The analogy relates not only to the clinical phenomena of the reaction but to the possibility of restitution by psychic stimuli.

The course of defatigation retraces, step by step and in regular, but reverse order, the phases, some seven in number, which modern graphic methods of registration demonstrate in the progress of fatigue, viz., by pupillography in the case of the eye and by a simple registering apparatus in the case of the patellar tendon reflex. For general biology, the *Restitutionseffekt* is of importance as an essential factor in the physiologic defatigation of organs supplied by the vegetative nervous system. In the pathologic field, this effect can be demonstrated as long as any remnant of function is preserved. The degree to which damaged function can be psychically restored shows how far it can be cured in spite of organic changes, and is, accordingly, of practical prognostic importance. If Löwenstein's earlier work gave "a method of exact physiologic measurement comparable to those of the perimeter and the tonometer," the present study is even more instructive and of wider bearing. It is significant that the author gives his title as former professor and director at the University of Bonn and directing physician of the Rhine-Provincial Sanatorium and that the work reviewed here comes from Switzerland and is published by a Swiss house.

Gegenseitige Auswertung der Augen-und Röntgensymptome bei der Tumordiagnostik im Sellabereich. By Dr. Willy Loepp, Königsberg. Price, 6.60 marks. Pp. 58, with 28 illustrations. Berlin: S. Karger, 1937.

The author of this book is director of the roentgenographic department of a hospital in Königsberg, and the book has been written with the assistance of the members of the staff of the ophthalmic clinic of the University of Königsberg.

Many tumors of the pituitary gland are slow in developing, and by the time the endocrine and vegetative disturbances become manifest the anatomic changes are so marked that treatment is unsatisfactory. An earlier diagnosis can be made by studying the disturbances of the optic nerves, with the exact localization of the retinal functions, and the bony changes in the sellar region. The pressure symptoms show the direction of growth and so suggest the site of origin. Examination of the visual fields is of the greatest importance and must be most carefully performed. Tumor of the hypophysis is no longer a sufficient diagnosis, but an exact diagnosis should be attempted. The knowledge concerning these tumors and related conditions permits the following classification: (1) tumor of the infundibular region, of the hypophysis, (2) tumor of the meninges, (3) tumor of the optic tracts and (4) aneurysm, hydrocephalus and similar conditions. The endocrine disturbances, the ocular changes (visual field, optic nerve and exophthalmos) and the value of roentgenographic findings are carefully

reviewed; the consideration of the last subject is the most valuable part of the monograph.

Twenty case histories, with a discussion, follow. Based on a study of 120 cases, the author makes the following conclusions: 1. Symptoms referable to the endocrine and vegetative system suggest a disturbance in the infundibular region of the hypophysis. 2. Careful examination of the optic paths and the bony skull should be made. 3. The changes revealed by such an examination are of value in their relation to one another. 4. The direction of growth is important. 5. A division of tumors according to their position in respect to the chiasm is desirable. 6. Examination of the visual fields is most important. 7. The form of enlargement of the sella turcica is also influenced by the size of the sphenoid sinus.

Twenty illustrations, showing the more important roentgenographic changes, are included.

ARNOLD KNAPP.

Zur Grundlegung der Blinden-Psychologie. By G. Révész, University of Amsterdam. Reprint of an Article in the Festschrift for Prof. Dr. Anathon Aall of the Kongelige Fredericks Universitet, Oslo, Norway. Pp. 12. Oslo, Norway: Det Mallingske Bogtrykkeri.

The mental and physical reactions of the blind to the outer world and those in it have always interested ophthalmologists from the practical side, as have the reeducation of those deprived of sight and their training in gainful occupations, trades and handicrafts. A classic contribution to the knowledge of what might be called the everyday psychology of the blind is, of course, Javal's "Entre aveugles." The work reviewed here considers matters from a more theoretic point of view and attempts to lay the foundation of a general psychology of blindness. The author, who is in charge of the psychologic laboratory at Amsterdam, has formulated what he considers the basic problems of this study as being to determine how the outer world is conceived and represented, respectively, by and to the mind of the sightless; what its structure is, and what characterizes the nature and origin of conceptual spatial forms. These are, of course, problems which refer to perceptual theory in general and, more particularly, to the study of the relations between the optical space world and that which is purely tactile, or, as the author styles it, haptic. This cognitive sense deals with space, objects and form. The history of this study and an analysis of the various "clinical" methods used in an attempt to fathom the workings of the minds of the blind are presented at length. This little work, which does not lend itself to abstracting or to a summary review, is instructive and will be read to advantage by those who are interested in the borderland topics of ophthalmology.

PERCY FRIDENBERG.

Directory of Ophthalmologic Societies *

INTERNATIONAL

INTERNATIONAL ASSOCIATION FOR PREVENTION OF BLINDNESS

Honorary President: Prof. F. de Lapersonne, 217 Fauborg St. Honoré, Paris.
President: Dr. P. Bailliar, 66 Boulevard Saint-Michel, Paris, 6^e.
Secretary-General: Prof. M. Van Duyse, Université de Gand, Gand, Prov. Ostflandern, Belgium.
All correspondence should be addressed to the President, Dr. P. Bailliar.

INTERNATIONAL OPHTHALMOLOGIC CONGRESS

Secretary: Dr. E. Marx, Costzeedijk 316, Rotterdam, Netherlands.

INTERNATIONAL ORGANIZATION AGAINST TRACHOMA

President: Dr. A. F. MacCallan, 33 Welbeck St., London, W., England.

FOREIGN

BRITISH MEDICAL ASSOCIATION, SECTION ON OPHTHALMOLOGY

President: Dr. Stewart Duke-Elder, 59 Harley St., London, W. I.
Secretary: Dr. Thomasina Belt, 13 Mitchell Ave., Jesmond, Newcastle-on-Tyne.
Place: Plymouth. Time: July 20-22, 1938.

CHINESE OPHTHALMOLOGICAL SOCIETY OF PEIPING

President: Dr. H. T. Pi, Peiping Union Medical College, Peiping.
Secretary: Dr. C. K. Lin, 180 Hsi-Lo-yen, Chienmeng, Peiping.
Place: Peiping Union Medical College, Peiping. Time: Last Friday of each month.

GERMAN OPHTHALMOLOGICAL SOCIETY

President: Prof. W. Lohlein, Berlin.
Secretary: Prof. E. Engelking, Heidelberg.
Place: Heidelberg. Time: July 4-6, 1938.

MIDLAND OPHTHALMOLOGICAL SOCIETY

President: Dr. T. E. Ashdown Carr, 34 Charnwood St., Derby, England.
Secretary: T. Harrison Butler, 81 Edmund St., Birmingham, England.
Place: Birmingham and Midland Eye Hospital.

OPHTHALMOLOGICAL SOCIETY OF EGYPT

President: Prof. Dr. Sayed Abdel Hamid Soliman Pasha, Faculty of Medicine, Cairo.
Secretary: Dr. Abdel Fattah El Tobgy, 3 Midan Soliman Pasha, Cairo.
Place: Memorial Ophthalmic Laboratory, Giza. Time: March 25, 1938.

OPHTHALMOLOGICAL SOCIETY OF THE UNITED KINGDOM

President: Mr. Gordon M. Holmes, 9 Wimpole St., London, W. 1.
Secretary: Mr. J. D. M. Cardell, 27 Weymouth St., London, W. 1.

OPHTHALMOLOGY SOCIETY OF BOMBAY

President: Dr. D. D. Sathaye, 127 Girgaum Road, Bombay 4.
Secretary: Dr. H. D. Dastur, Dadar, Bombay 14.
Place: H. B. A. Free Ophthalmic Hospital, Parel, Bombay 12. Time: First Friday of every month.

* Secretaries of societies are requested to furnish the information necessary to make this list complete and to keep it up to date.

OXFORD OPHTHALMOLOGICAL CONGRESS

Master: Dr. C. G. Russ Wood, Hill House, Abberbury Rd., Iffley, Oxford, England.
 Hon. Secretary-Treasurer: Dr. F. A. Anderson, 12 St. John's Hill, Shrewsbury, England.
 Time: July 7-9, 1938.

PALESTINE OPHTHALMOLOGICAL SOCIETY

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POLISH OPHTHALMOLOGICAL SOCIETY

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 Secretary: Dr. J. Sobański, Lindley'a 4, Warsaw.
 Place: Lindley'a 4, Warsaw.

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TSINAN OPHTHALMOLOGICAL SOCIETY

Chairman: Dr. Eugene Chan, Cheeloo University School of Medicine, Tsinan, Shantung.
 Place: Cheeloo University School of Medicine. Time: Last Thursday of alternate months.

NATIONAL

AMERICAN MEDICAL ASSOCIATION, SCIENTIFIC ASSEMBLY, SECTION ON OPHTHALMOLOGY

Chairman: Dr. Parker Heath, 1553 Woodward Ave., Detroit.
 Secretary: Dr. Derrick T. Vail Jr., 441 Vine St., Cincinnati.
 Place: San Francisco. Time: June 13-17, 1938.

AMERICAN ACADEMY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY, SECTION ON OPHTHALMOLOGY

President: Dr. Harry S. Gradle, 58 E. Washington St., Chicago.
 Executive Secretary-Treasurer: Dr. William P. Wherry, 1500 Medical Arts Bldg., Omaha.
 Place: Washington, D. C. Time: Oct. 9-14, 1938.

AMERICAN OPHTHALMOLOGICAL SOCIETY

President: Dr. Frederick H. Verhoeff, 243 Charles St., Boston.
 Secretary-Treasurer: Dr. Eugene M. Blake, 303 Whitney Ave., New Haven, Conn.
 Place: San Francisco. Time: June 9-11, 1938.

CANADIAN OPHTHALMOLOGICAL SOCIETY

President: Dr. W. Gordon M. Byers, 1458 Mountain St., Montrea.
 Secretary-Treasurer: Dr. Alexander E. MacDonald, 421 Medical Arts Bldg., Toronto.

NATIONAL SOCIETY FOR THE PREVENTION OF BLINDNESS

President: Mr. William Fellowes Morgan, 50 W. 50th St., New York.
Secretary: Miss Regina E. Schneider, 50 W. 50th St., New York.

SECTIONAL

CENTRAL WISCONSIN SOCIETY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

President: Dr. L. C. Gardner, 11 N. Main St., Fond du Lac.
Secretary: Dr. G. L. McCormick, 626 S. Central Ave., Marshfield.
Place: Marshfield. Time: May 1938.

NEW ENGLAND OPHTHALMOLOGICAL SOCIETY

President: Dr. Edwin B. Goodall, 101 Bay State Rd., Boston.
Secretary-Treasurer: Dr. William P. Beetham, 5 Bay State Rd., Boston.
Place: Massachusetts Eye and Ear Infirmary, 243 Charles St., Boston. Time:
8 p. m., third Tuesday of each month from November to April, inclusive.

PACIFIC COAST OTO-OPHTHALMOLOGICAL SOCIETY

President: Dr. William D. Donohue, 1930 Wilshire Blvd., Los Angeles.
Secretary-Treasurer: Dr. C. Allen Dickey, 450 Sutter St., San Francisco.
Place: Victoria, B. C. Time: June 21-24, 1938.

PUGET SOUND ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. A. W. Howe, 740 St. Helens Ave., Tacoma, Wash.
Secretary-Treasurer: Dr. Purman Dorman, 1115 Terry Ave., Seattle.
Place: Seattle or Tacoma, Wash. Time: Third Tuesday of each month, except
June, July and August.

ROCK RIVER VALLEY EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. Frank W. Broderick, 501 Central Trust Bldg., Sterling, Ill.
Secretary-Treasurer: Dr. Thorsten E. Blomberg, 501-7th St., Rockford, Ill.
Place: Rockford, Ill., or Janesville or Beloit, Wis. Time: Third Tuesday of
each month.

SAGINAW VALLEY ACADEMY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

President: Dr. W. K. Slack, 308 Eddy Bldg., Saginaw, Mich.
Secretary-Treasurer: Dr. Andre Cortopassi, 703 Second National Bank Bldg.,
Saginaw, Mich.
Place: Saginaw or Bay City, Mich. Time: Second Tuesday of each month,
except July and August.

SIoux VALLEY EYE AND EAR ACADEMY

President: Dr. J. H. Judd, 107 S. 17th St., Omaha, Neb.
Secretary-Treasurer: Dr. J. C. Decker, 515 Frances Bldg., Sioux City, Iowa.

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Rapids, Mich.
Time: Third Thursday of alternate months.

WESTERN PENNSYLVANIA EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. C. M. Harris, Johnstown, Pa.
Secretary-Treasurer: Dr. C. Wearne Beals, Weber Bldg., DuBois.
Place: Johnstown, Pa. Time: May 19, 1938.

STATE

COLORADO OPHTHALMOLOGICAL SOCIETY

President: A presiding officer is selected for each meeting alternately until all members have served.

Secretary: Dr. John C. Long, 324 Metropolitan Bldg., Denver.

Place: Capitol Life Bldg., Denver. Time: 7:30 p. m., third Saturday of the month, October to April, inclusive.

CONNECTICUT STATE MEDICAL SOCIETY, SECTION ON EYE, EAR,
/ NOSE AND THROAT

President: Dr. Charles T. Flynn, 41 Trumbull St., New Haven.

Secretary-Treasurer: Dr. Shirley H. Baron, 309 State St., New London.

Place: New London. Time: February 1938.

EYE, EAR, NOSE AND THROAT CLUB OF GEORGIA

President: Dr. John King, Thomasville.

Secretary-Treasurer: Dr. Mason Baird, 384 Peachtree St., Atlanta.

Place: Augusta. Time: May 1938.

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President: Dr. E. E. Holland, 51 S. 8th St., Richmond.

Secretary: Dr. Marlow W. Manion, 23 E. Ohio St., Indianapolis.

Place: Indianapolis. Time: April 6, 1938.

IOWA ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. H. H. Lamb, American Bank Bldg., Davenport.

Secretary-Treasurer: Dr. B. M. Merkel, 604 Locust St., Des Moines.

Place: Davenport.

LOUISIANA-MISSISSIPPI OPHTHALMOLOGICAL AND OTOLARYNGOLOGICAL SOCIETY

President: Dr. C. A. McWilliams, G. and S. I. R. R. Bldg., Gulfport, Miss.

Secretary-Treasurer: Dr. Edley H. Jones, 1301 Washington St., Vicksburg, Miss.

Place: New Orleans. Time: Spring, 1938.

MICHIGAN STATE MEDICAL SOCIETY, SECTION OF OPHTHALMOLOGY
AND OTOLARYNGOLOGY

Chairman: Dr. F. N. Smith, Grand Rapids Clinic, Grand Rapids.

Secretary: Dr. Dewey R. Heetderks, 26 Sheldon Ave., S. E., Grand Rapids.

MINNESOTA ACADEMY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

President: Dr. Walter E. Camp, 1918 Medical Arts Bldg., Minneapolis.

Secretary-Treasurer: Dr. George E. McGeary, 920 Medical Arts Bldg., Minneapolis.

Time: Second Friday of each month from October to May.

MONTANA ACADEMY OF OTO-OPHTHALMOLOGY

President: Dr. Roy Grigg, Bozeman.

Secretary: Dr. A. W. Morse, 507 Phoenix Bldg., Butte.

NEW JERSEY STATE MEDICAL SOCIETY, SECTION ON OPHTHALMOLOGY,
OTOLOGY AND RHINOLARYNGOLOGY

Chairman: Dr. Oram Kline, 414 Cooper St., Camden.

Secretary: Dr. James S. Shipman, 542 Cooper St., Camden.

NEW YORK STATE MEDICAL SOCIETY, EYE, EAR, NOSE AND THROAT SECTION

Chairman: Dr. Marvin F. Jones, 121 E. 60th St., New York.

Secretary: Dr. Algernon B. Reese, 73 E. 71st St., New York.

Time: May 10, 1938.

NORTH CAROLINA EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. J. M. Lilly, 302 Old St., Fayetteville.
Secretary-Treasurer: Dr. Frank C. Smith, 106 W. 7th St., Charlotte.
Place: Charlotte. Time: October.

NORTH DAKOTA ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. H. Rosenberger, 221-5th St., Bismarck.
Secretary-Treasurer: Dr. F. L. Wicks, 514-6th St., Valley City.
Place: Bismarck. Time: May 1938.

OREGON ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. A. B. Dykman, Medical Dental Bldg., Portland.
Secretary-Treasurer: Dr. Andrew J. Browning, 418 Mayer Bldg., Portland.
Place: Good Samaritan Hospital. Time: Third Tuesday of each month.

RHODE ISLAND OPHTHALMOLOGICAL AND OTOLOGICAL SOCIETY

Acting President: Dr. N. Darrell Harvey, 112 Waterman St., Providence.
Secretary-Treasurer: Dr. Linley C. Happ, 124 Waterman St., Providence.
Place: Rhode Island Medical Library. Time: 8:30 p. m., second Thursday in October, December, February and April.

SOUTH CAROLINA SOCIETY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

President: Dr. George Truluck, Orangeburg.
Secretary: Dr. J. W. Jervey Jr., 101 Church St., Greenville.

TENNESSEE ACADEMY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

President: Dr. Kate Savage Zerfoss, 165-8th Ave., N., Nashville.
Secretary-Treasurer: Dr. W. D. Stinson, 805 Medical Arts Bldg., Memphis.
Place: Nashville. Time: April 12-13, 1938.

TEXAS OPHTHALMOLOGICAL AND OTO-LARYNGOLOGICAL SOCIETY

President: Dr. T. E. Fuller, 100 W. Board St., Texarkana, Texas.
Secretary: Dr. O. M. Marchman, 1719 Pacific Ave., Dallas.

UTAH OPHTHALMOLOGICAL SOCIETY

President: Dr. V. P. White, 143½ S. Main St., Salt Lake City.
Secretary-Treasurer: Dr. E. B. Fairbanks, Boston Bldg., Salt Lake City.
Time: Third Monday of each month.

VIRGINIA SOCIETY OF OTO-LARYNGOLOGY AND OPHTHALMOLOGY

President: Dr. M. H. Hood, 505 Washington St., Portsmouth.
Secretary-Treasurer: Dr. Charles T. St. Clair, 418 Bland St., Bluefield, W. Va.

WEST VIRGINIA STATE MEDICAL ASSOCIATION, EYE, EAR, NOSE
AND THROAT SECTION

President: Dr. George Traugh, 309 Cleveland Ave., Fairmont.
Secretary: Dr. Welch England, 621½ Market St., Parkersburg.

LOCAL

ACADEMY OF MEDICINE OF NORTHERN NEW JERSEY, SECTION ON
EYE, EAR, NOSE AND THROAT

President: Dr. James A. Fisher, 501 Grand Ave., Asbury Park.
Secretary: Dr. William F. McKim, 488 Sanford Ave., Newark.
Place: 91 Lincoln Park South, Newark. Time: 8:45 p. m., second Monday of each month, October to May.

AKRON ACADEMY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

President: Dr. L. E. Brown, Second National Bldg., Akron.
 Secretary-Treasurer: Dr. C. R. Anderson, 106 S. Main St., Akron.
 Time: First Monday in January, March, May and November.

ATLANTA EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. J. Mason Baird, Medical Arts Bldg., Atlanta, Ga.
 Secretary: Dr. Alton V. Hallum, 478 Peachtree St., Atlanta, Ga.
 Place: Academy of Medicine, 38 Prescott St. Time: Second Friday of each month from October to May.

BALTIMORE MEDICAL SOCIETY, SECTION ON OPHTHALMOLOGY

Chairman: Dr. Henry F. Graff, 513 N. Charles St., Baltimore.
 Secretary: Dr. Frank B. Walsh, Wilmer Institute, Johns Hopkins Hospital, Baltimore.
 Place: Medical and Chirurgical Faculty, 1211 Cathedral St. Time: 8:30 p. m., fourth Thursday of each month from October to May.

BROOKLYN OPHTHALMOLOGICAL SOCIETY

President: Dr. Walter V. Moore, 1 Nevins St., Brooklyn.
 Secretary-Treasurer: Dr. Mortimer A. Lasky, 1 Nevins St., Brooklyn.
 Place: Kings County Medical Society Bldg., 1313 Bedford Ave. Time: Third Thursday in February, April, May, October and December.

BUFFALO OPHTHALMOLOGIC CLUB

President: Dr. Ivan J. Koenig, 40 North St., Buffalo.
 Secretary-Treasurer: Dr. Meyer H. Riweh, 367 Linwood Ave., Buffalo.
 Time: Second Thursday of each month.

CHATTANOOGA SOCIETY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

President: Each member, in alphabetical order.
 Secretary: Dr. A. H. Benz, 706 Medical Arts Bldg., Chattanooga.
 Place: Mountain City Club. Time: Second Thursday of each month from September to May.

CHICAGO OPHTHALMOLOGICAL SOCIETY

President: Dr. Georgiana Dvorak-Theobald, 715 Lake St., Oak Park.
 Secretary-Treasurer: Dr. Earle B. Fowler, 55 E. Washington St., Chicago.
 Place: Medinah Michigan Avenue Club, 505 N. Michigan Ave. Time: Third Monday of each month from October to May.

CINCINNATI OPHTHALMIC CLUB

Chairman: Each member, in rotation.
 Secretary-Treasurer: Dr. E. R. Thomas, 819 Carew Tower, Cincinnati.
 Place: Holmes Memorial Library, Cincinnati General Hospital. Time: 8:15 p. m., third Monday of each month except June, July and August.

CLEVELAND ACADEMY OF MEDICINE, SECTION OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

Chairman: Dr. Webb Chamberlin, 7405 Detroit Ave., Cleveland.
 Secretary: Dr. Walter H. Rieger, Hanna Bldg., Cleveland.
 Place: Winton Hotel. Time: Fourth Friday of each month.

CLEVELAND OPHTHALMOLOGICAL CLUB

Chairman: Dr. Paul Moore, Republic Bldg., Cleveland.
 Secretary: Dr. G. Leslie Miller, 14805 Detroit Ave., Cleveland.
 Time: Second Tuesday in October, December, February and April.

COLLEGE OF PHYSICIANS, PHILADELPHIA, SECTION ON OPHTHALMOLOGY

Chairman: Dr. Charles R. Heed, 1205 Spruce St., Philadelphia.
 Clerk: Dr. Alexander G. Fewell, 1924 Pine St., Philadelphia.
 Time: Third Thursday of every month from October to April, inclusive.

COLUMBUS OPHTHALMOLOGICAL AND OTO-LARYNGOLOGICAL SOCIETY

Chairman: Dr. C. E. Silbernagle, 247 E. State St., Columbus, Ohio.
 Secretary-Treasurer: Dr. D. M. Johnson, 327 E. State St., Columbus, Ohio.
 Place: Deshler Wallick Hotel. Time: 6 p. m., first Monday of each month.

CORPUS CHRISTI EYE, EAR, NOSE AND THROAT SOCIETY

Chairman: Dr. Edgar G. Mathis, 416 Chaparral St., Corpus Christi, Texas.
 Secretary: Dr. E. King Gill, 416 Chaparral St., Corpus Christi, Texas.
 Time: Second Thursday of each month from October to May.

DALLAS ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. Lester H. Quinn, 4105 Live Oak, Dallas, Texas.
 Secretary: Dr. J. Dudley Singleton, 1719 Pacific Ave., Dallas, Texas.
 Place: Dallas Athletic Club. Time: 6:30 p. m., first Tuesday of each month from October to June. The November, January and March meetings are devoted to clinical work.

DES MOINES ACADEMY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

President: Dr. E. G. Linn, 604 Locust St., Des Moines, Iowa.
 Secretary-Treasurer: Dr. Grace Doane, 614 Bankers Trust Bldg., Des Moines, Iowa.
 Time: 7:45 p. m., third Monday of every month from September to May.

DETROIT OPHTHALMOLOGICAL CLUB

Chairman: Members rotate alphabetically.
 Secretary: Dr. William Fowler, 1424 Maccabee Bldg., Detroit.
 Time: 6:30 p. m., first Wednesday of each month.

EASTERN NEW YORK EYE, EAR, NOSE AND THROAT ASSOCIATION

President: Dr. J. D. Carroll, 102—3d St., Troy, N. Y.
 Secretary-Treasurer: Dr. Joseph L. Holohan, 330 State St., Albany.
 Time: Third Wednesday in October, November, March, April, May and June.

FORT WORTH EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. Van D. Rathgeber, 1012 Medical Arts Bldg., Fort Worth, Texas.
 Secretary-Treasurer: Dr. Charles R. Lees, 306 W. Broadway, Fort Worth, Texas.
 Place: Medical Hall, Medical Arts Bldg. Time: 7:30 p. m., first Friday of each month except July and August.

GRAND RAPIDS EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. Dewey R. Heetderks, 405 Medical Arts Bldg., Grand Rapids, Mich.
 Secretary-Treasurer: Dr. Robert G. Laird, 116 E. Fulton St., Grand Rapids, Mich.
 Place: Various local hospitals. Time: Third Thursday of alternating months, September to May.

HOUSTON ACADEMY OF MEDICINE, EYE, EAR, NOSE AND THROAT SECTION

President: Dr. L. Allen, 1215 Walker Ave., Houston, Texas.
 Secretary: Dr. George C. Farrish, 1625 Main St., Houston, Texas.
 Place: Medical Arts Bldg., Harris County Medical Society Rooms. Time: 8 p. m., second Thursday of each month from September to June.

INDIANAPOLIS OPHTHALMOLOGICAL AND OTOLARYNGOLOGICAL SOCIETY

President: Dr. C. P. Clark, 24 E. Ohio St., Indianapolis.

Secretary: Dr. Kenneth L. Craft, 23 E. Ohio St., Indianapolis.

Place: University Club. Time: 6:30 p. m., second Thursday of each month from October to May.

KANSAS CITY SOCIETY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. O. S. Gilliland, 1103 Grand Ave., Kansas City, Mo.

Secretary: Dr. John S. Knight, 1103 Grand Ave., Kansas City, Mo.

Time: Third Thursday of each month from September to May. The November, January and March meetings are devoted to clinical work.

LONG BEACH EYE, EAR, NOSE AND THROAT SOCIETY

Chairman: Dr. F. C. Hertzog, 117 E. 8th St., Long Beach, Calif.

Secretary-Treasurer: Dr. Ben K. Parks, 619 Professional Bldg., Long Beach, Calif.

Place: Professional Bldg. Time: Last Wednesday of each month from October to May.

LOS ANGELES SOCIETY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. Clifford B. Walker, 427 W. 5th St., Los Angeles.

Secretary-Treasurer: Dr. John P. Lordan, 2007 Wilshire Blvd., Los Angeles.

Place: Los Angeles County Medical Association Bldg., 1925 Wilshire Blvd. Time: 6:30 p. m., fourth Monday of each month from September to May, inclusive.

LOUISVILLE EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. J. S. Bumgardner, Heyburn Bldg., Louisville, Ky.

Secretary-Treasurer: Dr. Max Bornstein, Heyburn Bldg., Louisville, Ky.

Place: Brown Hotel. Time: 6:30 p. m., second Thursday of each month from September to May, inclusive.

MEDICAL SOCIETY OF THE DISTRICT OF COLUMBIA, SECTION OF
OPHTHALMOLOGY AND OTOLARYNGOLOGY

Chairman: Dr. Earle Breeding, 1801 I St., N. W., Washington.

Secretary: Dr. Elmer Shepherd, 1606-20th St., N. W., Washington.

Place: 1718 M St., N. W. Time: 8 p. m., third Friday of each month from October to April, inclusive.

MEMPHIS SOCIETY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

Chairman: Each member, in alphabetical order.

Secretary: Dr. Sam H. Sonders, Medical Arts Bldg., Memphis, Tenn.

Place: Eye Clinic of Memphis Eye, Ear, Nose and Throat Hospital. Time: 8 p. m., second Tuesday of each month.

MILWAUKEE OTO-OPHTHALMIC SOCIETY

President: Dr. Thomas A. Judge, 735 N. Water St., Milwaukee.

Secretary-Treasurer: Dr. John B. Hitz, 208 E. Wisconsin Ave., Milwaukee.

Place: University Club. Time: 6:30 p. m., second Tuesday of each month.

MINNEAPOLIS OPHTHALMOLOGICAL SOCIETY

Chairman: Each member, in alphabetical order.

Secretary: Dr. M. C. Pfunder, 645 Medical Arts Bldg., Minneapolis.

Place: Hennepin County Medical Society rooms. Time: 6:30 p. m., fourth Monday of each month, October to May, inclusive.

MONTGOMERY COUNTY MEDICAL SOCIETY

Chairman: Dr. A. G. Farmer, 1040 Fidelity Bldg., Dayton, O.

Secretary-Treasurer: Dr. Rome M. Webster, 663 Reibold Bldg., Dayton, O.

Place: Van Cleve Hotel. Time: 6:30 p. m., bimonthly, first Tuesday from October to June, inclusive.

MONTREAL OPHTHALMOLOGICAL SOCIETY

President: Dr. Stuart Ramsay, 1496 Mountain St., Montreal, Canada.
 Secretary: Dr. J. Rosenbaum, 1396 St. Catherine St., W., Montreal, Canada.
 Time: Second Thursday of October, December, February and April.

NASHVILLE ACADEMY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

Chairman: Dr. Guy Maness, 119-7th Ave., Nashville, Tenn.
 Secretary-Treasurer: Dr. Andrew Hollabaugh, Doctors Bldg., Nashville, Tenn.
 Place: St. Thomas Hospital. Time: 8 p. m., third Monday of each month from October to May.

NEW ORLEANS OPHTHALMOLOGICAL AND OTOLARYNGOLOGICAL SOCIETY

President: Dr. R. H. Fisher, Chess and Checker Club, New Orleans.
 Secretary-Treasurer: Dr. H. F. Brewster, 837 Gravier St., New Orleans.
 Place: Eye, Ear, Nose and Throat Hospital. Time: Third Thursday of each month from October to June.

NEW YORK ACADEMY OF MEDICINE, SECTION OF OPHTHALMOLOGY

Chairman: Dr. James W. White, 15 Park Ave., New York.
 Secretary: Dr. Rudolf Aebli, 30 E. 40th St., New York.
 Time: 8:30 p. m., third Monday of every month from October to May, inclusive.

NEW YORK SOCIETY FOR CLINICAL OPHTHALMOLOGY

President: Dr. Mark J. Schoenberg, 1160 Park Ave., New York.
 Secretary: Dr. Jesse Stark, 45 Park Ave., New York.
 Place: Squibb Hall, 745-5th Ave. Time: 7 p. m., first Monday of each month from October to May, inclusive.

OMAHA AND COUNCIL BLUFFS OPHTHALMOLOGICAL AND
 OTO-LARYNGOLOGICAL SOCIETY

President: Dr. A. J. Young, 107 S. 17th St., Omaha.
 Secretary-Treasurer: Dr. Delbert K. Judd, 1020 Medical Arts Bldg., Omaha.
 Place: Omaha Club, 20th and Douglas Sts., Omaha. Time: 6 p. m., dinner;
 7 p. m., program; third Wednesday of each month from October to May.

OPHTHALMOLOGICAL SOCIETY OF THE UNIVERSITY OF PITTSBURGH

President: Dr. W. W. Blair, 121 University Pl., Pittsburgh.
 Secretary: Dr. George H. Shuman, 351-5th Ave., Pittsburgh.
 Time: Second Monday in November, January, March and May.

PASSAIC-BERGEN OPHTHALMOLOGICAL CLUB

President: Dr. John S. Van Winkle, 297 Broadway, Paterson, N. J.
 Secretary-Treasurer: Dr. T. A. Sanfacon, 340 Park Ave., Paterson, N. J.
 Place: Paterson Eye and Ear Infirmary. Time: 9 p. m., last Friday of every month, except June, July and August.

PHILADELPHIA COUNTY MEDICAL SOCIETY, EYE SECTION

Chairman: Dr. Sidney L. Olsho, 235 S. 15th St., Philadelphia.
 Secretary: Dr. Edmund B. Spaeth, 1930 Chestnut St., Philadelphia.
 Time: First Thursday of each month from October to May.

PITTSBURGH OPHTHALMOLOGICAL SOCIETY

President: Dr. Glendon E. Curry, Westinghouse Bldg., Pittsburgh.
 Secretary: Dr. George H. Shuman, 351-5th Ave., Pittsburgh.
 Place: Pittsburgh Academy of Medicine Bldg. Time: Fourth Monday of each month, except June, July, August and September.

RICHMOND OPHTHALMOLOGICAL AND OTO-LARYNGOLOGICAL SOCIETY

President: Dr. N. H. Turner, 200 E. Franklin St., Richmond, Va.
 Secretary: Dr. Richard W. Vaughan, Medical Arts Bldg., Richmond, Va.
 Place: Westmoreland Club. Time: 6 p. m., second Monday of each month from October to May.

ROCHESTER EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. R. E. Elliott, 78 S. Fitzhugh St., Rochester, N. Y.
 Secretary-Treasurer: Dr. Raphael Farber, 280 Monroe Ave., Rochester, N. Y.
 Place: Rochester Medical Association, 113 Prince St. Time: 8 p. m., third Monday of each month from October to May.

ST. LOUIS OPHTHALMIC SOCIETY

President: Dr. Lawrence T. Post, 508 N. Grand Blvd., St. Louis.
 Secretary: Dr. Leslie Charles Drews, 508 N. Grand Blvd., St. Louis.
 Place: Oscar Johnson Institute. Time: Clinical meeting 5:30 p. m., dinner and scientific meeting 6:30 p. m., fourth Friday of each month from October to April, inclusive, except December.

SAN ANTONIO OPHTHALMOLO-OTO-LARYNGOLOGICAL SOCIETY

President: Dr. Oscar H. Judkins, 414 Navarro St., San Antonio, Texas.
 Secretary-Treasurer: Dr. Wilfred E. Muldoon, 414 Navarro St., San Antonio, Texas.
 Place: Bexar County Medical Library. Time: 8 p. m., first Tuesday of each month from October to May.

SAN FRANCISCO COUNTY MEDICAL SOCIETY, SECTION ON EYE, EAR, NOSE AND THROAT

Chairman: Dr. Russell Fletcher, 490 Post St., San Francisco.
 Secretary: Dr. Avery Morley Hicks, 490 Post St., San Francisco.
 Place: Society's Bldg., 2180 Washington St., San Francisco. Time: Fourth Tuesday of every month except May, June, July and December.

SHREVEPORT EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. J. A. Wilkinson, Medical Arts Bldg., Shreveport, La.
 Secretary-Treasurer: Dr. W. L. Atkins, 940 Margaret Pl., Shreveport, La.
 Place: Shreveport Charity Hospital. Time: 7:30 p. m., first Monday of every month except July, August and September.

SPOKANE ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. Raymond A. Lower, 407 Riverside Ave., Spokane, Wash.
 Secretary: Dr. Louis A. Parsell, Paulsen Medical and Dental Bldg., Spokane, Wash.
 Place: Paulsen Medical and Dental Library. Time: 8 p. m., fourth Tuesday of each month except June, July and August.

SYRACUSE EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. Gordon D. Hoople, 110 Medical Arts Bldg., Syracuse, N. Y.
 Secretary-Treasurer: Dr. I. Herbert Katz, 212 Medical Arts Bldg., Syracuse, N. Y.
 Place: University Club. Time: First Tuesday of each month except June, July and August.

TORONTO ACADEMY OF MEDICINE, SECTION OF OPHTHALMOLOGY

Chairman: A. Lloyd Morgan, Medical Arts Bldg., Toronto, Canada.
 Secretary: Dr. W. R. F. Luke, Medical Arts Bldg., Toronto, Canada.
 Place: Academy of Medicine, 13 Queen's Pk. Time: First Monday of each month, November to April.

WASHINGTON, D. C., OPHTHALMOLOGICAL SOCIETY

President: Dr. G. Victor Simpson, 1710 Rhode Island Ave., N. W., Washington, D. C.
 Secretary-Treasurer: Dr. Frank D. Costenbader, 1726 I St., Washington, D. C.
 Place: Episcopal Eye, Ear and Throat Hospital. Time: 8 p. m., first Monday in November, January, March and May.

ANOMALOUS PROJECTION AND OTHER VISUAL PHENOMENA ASSOCIATED WITH STRABISMUS

F. H. VERHOEFF, M.D.

BOSTON

The purpose of this communication is to correct what I believe to be misconceptions concerning certain visual phenomena associated with strabismus by pointing to significant facts hitherto overlooked or disregarded. These misconceptions are so prevalent that their correction is of considerable importance. Of the misconceptions in question, probably the most misleading relate to anomalous projection.

Before this remarkable phenomenon can be intelligibly discussed, it is essential that a precise definition of corresponding retinal points be given. Many such definitions have been attempted, some of which are evidently inaccurate, while others are inadequate or ambiguous.¹ The following definition, which, so far as I know, has never previously been definitely expressed, has certain advantages, particularly for the purpose of discriminating between normal and anomalous projection. With the head stationary, fix with one eye (for the present assumed to be the right) the center of any suitable object, *A*, as in figure 1, in external space. (In this diagram, the objects, each of suitable size, are indicated by their centers.) The primary visual axis of the right eye will now intersect that of the left eye at some point, *P*. In the case of a person with binocular fixation, *A* and *P* will coincide, but in the case of a squinter, *A* is supposed to be so placed as not to coincide with *P*. It is, of course, assumed that after fixation of *A* has been

Read before the Section of Ophthalmology, New York Academy of Medicine, Jan. 17, 1938.

From the Howe Laboratory of Ophthalmology, Harvard University, and the Massachusetts Eye and Ear Infirmary.

1. A definition that corresponding retinal points are retinal points which are projected to the same place in space does not include the case in which an image on one retinal area is projected 6 inches (15 cm.) away and an image on the corresponding area is projected 6 miles (9,656 meters) away. On the other hand, as will be seen later, a definition that corresponding retinal points are retinal points that are projected in the same direction does not distinguish between normal and anomalous projection. The definition at which I arrive avoids these and other difficulties.

attained by the right eye, both eyes remain stationary. Select any other object, N , in the binocular field. The image of N in the right eye is centered on a certain retinal point, r . Place another object, C , so that its retinal image in the right eye is also centered at r . The line NC is defined as the visual axis of r and also as the right visual axis of N . With both eyes open, place an object, D , so that as seen from the left eye its center appears in line with the centers of N and C as seen from the right eye. (That any particular objects are seen only from a designated eye can be assured when necessary by the use of suitable screens² or in other obvious ways that do not require detailed description.) The image of D in the left eye is centered at a certain retinal point, r' . Place another object, E , so that its retinal image in the left eye is also centered at r' . If it is now found that the centers of the objects D and E as seen from the left eye appear in line with the centers of the objects N and C as seen from the right eye, NC and DE are corresponding visual axes, and r and r' are corresponding retinal points.

Observations in numerous cases have demonstrated that when any two visual axes thus correspond they do so only with respect to each other and continue to do so for all positions of the eyes, whether or not these positions are attained by changes in the motor innervation. Therefore, within the binocular field, for each of the various visual axes in one eye there is one and only one corresponding visual axis in the other eye, and corresponding retinal points have fixed anatomic positions on the retinas.³ It has also been found that when retinal correspondence exists, the axes ordinarily considered to be primary visual axes are corresponding visual axes. That retinal correspondence always means that the correspondence is fixed accords with all previous conceptions of retinal correspondence.

The foregoing definitions may be more concisely stated as follows: A visual axis is defined as any line in external space, all suitable objects centered on which have their retinal images centered at the same retinal

2. The introduction of a suitable screen to obstruct from one eye only the view of an object does not necessarily establish unusual conditions. Similar conditions often exist in ordinary vision, for instance, when a tree obstructs only from one eye the view of a more distant object.

3. This brings up the questions of Panum's areas and the so-called fusion of disparate images, but for the purpose of the present communication these are unimportant. I have discussed them elsewhere (*A New Theory of Binocular Vision*, *Arch. Ophth.* **13**:151 [Feb.] 1935) and have explicitly denied that "fusion" of disparate images ever occurs. One experienced in precise stereoscopic observations can easily ascertain that the "fusion" in question in reality consists in complete replacement of one of a pair of disparate images, not by the other image (as may occur in the case of corresponding images) but by the part of the visual field represented on the other retina in the area exactly corresponding to the area occupied by the image replaced.

point.⁴ This point is termed the retinal optical terminal of the visual axis concerned.

Corresponding visual axes are defined as any two visual axes that as visualized from their respective eyes with the aid of suitable objects appear to coincide. The imaginary line in which they thus appear to coincide is termed a binocular visual axis.

Corresponding retinal points are defined as the retinal optical terminals of a pair of corresponding visual axes.

The question as to the apparent position of any binocular visual axis is complex but does not require discussion in this communication. Noncorresponding retinal points are called disparate points. Retinal correspondence in normal eyes is so precise that under suitable conditions disparateness of less than 1 second of arc may be recognized as difference in depth.⁵

In normal binocular vision the primary visual axes intersect at the point of binocular fixation. Because of torsional deviations and other factors, the other corresponding axes seldom actually intersect, as do *DE* and *NC* at *K* in figure 1, but cross above or below each other. For present purposes, however, as well as for many others, it can be assumed that they nearly intersect. The surface in which they most nearly do so is the observer's horopter for the fixation point concerned.⁶

It is commonly believed that in certain cases of strabismus a condition develops that is usually termed anomalous retinal correspondence, in which corresponding retinal points are abnormally related, so that the macula of the fixing eye corresponds not to that of the squinting eye but to some other fixed retinal area in that eye, called the false macula.⁷ This conception is indicated by the expression "anomalous correspondence adapted to the angle of squint," used by Bielschowsky.⁸ That the conception is erroneous in its fundamental assumption that

4. Possible slight effects of changes in accommodation and pupillary size on a visual axis need be taken into account only when exceptionally high precision is required, and for present purposes they may be disregarded.

5. Anderson, E., and Weymouth, F.: Visual Perception and the Retinal Mosaic, *Am. J. Physiol.* **64**:561, 1923.

6. The surface on which objects situated on the horopter appear to the observer to be located may be termed his subjective horopter. The horopter and the subjective horopter may or may not coincide in whole or in part. The discrepancy between the two may differ for different persons and for the same person under different conditions and at different times. The question of the location of the subjective horopter closely concerns that of aniseikonia.

7. The prevalence of this misconception is shown by the fact that it is held by the writers of standard textbooks, including Duke-Elder (*Textbook of Ophthalmology*, London, Henry Kimpton, 1932, vol. 1, p. 1030). T. Travers, in his recent monograph (*The Comparison Between Methods Employed for the Treatment of Concomitant Strabismus*, London, George Pulman & Sons, Ltd., 1936), sets forth this misconception as if it were an established fact.

8. Bielschowsky, A.: The Etiology of Squint, *Am. J. Ophth.* **20**:478, 1937.

fixed retinal correspondence exists in the cases referred to can be conclusively demonstrated by the method just used for defining corresponding retinal points. For in such cases of strabismus, whether convergent or divergent, I have found by this method not only that the primary visual axes do not correspond to each other but that each of various visual axes in the squinting eye, including the primary visual axis and even the axis of the "false macula," has no corresponding axis in the other eye. I have found also that this holds true for various

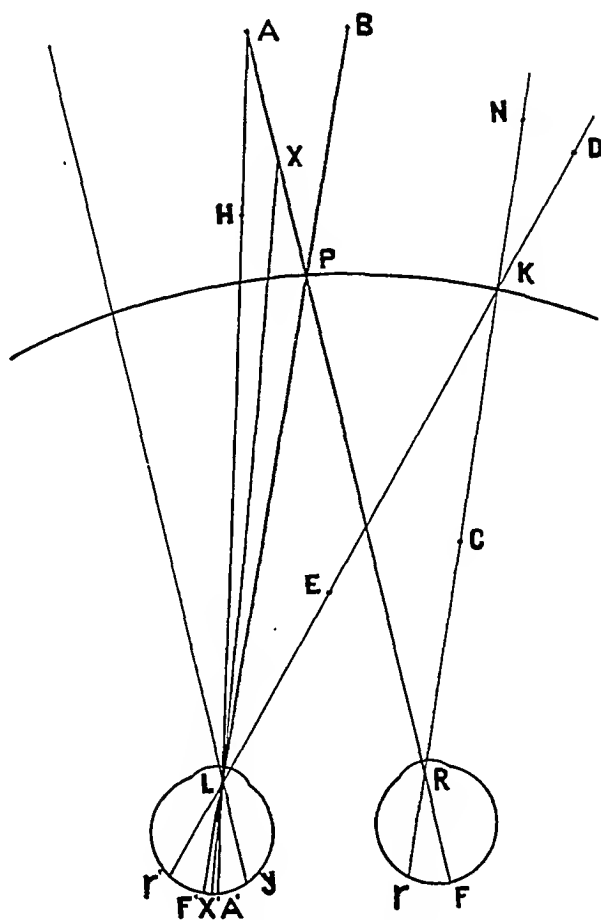


Chart 1.—Diagram for explaining corresponding visual axis, corresponding retinal points and anomalous projection.

positions and therefore presumably for all positions of the eyes. Hence in such cases there are no corresponding visual axes and consequently no corresponding retinal points.⁹ It is to be noted that in binocular vision, when there is correct projection in the cases under consideration, the object *D* seen from the left eye only (fig. 1) will be placed on and

9. This fact was demonstrated by me in a somewhat different fashion thirty-six years ago (*The Theory of the Vicarious Fovea Erroneous*, *Ophth. Rec.* **10**:300, 1901).

appear to lie on the line *NC*, and the object *E* will appear to lie not on this line but in its correct position.

In such cases, therefore, the type of binocular projection differs fundamentally from that of a normal person and the term anomalous type of binocular projection (or, for the sake of brevity, anomalous projection) may properly be applied to it. Although this term is not as descriptive as is desirable and hence may continue to be misunderstood, I retain it because it is in somewhat common use. Anomalous projection may now be explicitly defined as a type of binocular projection in which there are no corresponding visual axes, or as a type of binocular projection without retinal correspondence. The terms anomalous correspondence, abnormal correspondence and false macula are clearly misleading, since in the cases of strabismus to which these terms are applied there is no fixed retinal correspondence to be anomalous or abnormal.

It is commonly assumed that anomalous projection exists only in unusual cases. I have not attempted to demonstrate it in children under 8 years of age and have not persisted in the attempts to do so in a few patients whose replies were obviously unreliable. But, with these exceptions, I have been able invariably to demonstrate anomalous projection in numerous persons with established concomitant strabismus. I have found also that anomalous projection may occur in persons with sursumvergent strabismus, but at present I am unable to state the frequency with which it occurs.

The question now arises as to the meaning of the term "normal retinal correspondence." Obviously, for the purpose of distinguishing between the vision of the nonsquinter and that of the squinter, the term need imply only the existence of corresponding retinal axes and corresponding retinal points, without regard to the positions of these axes and points; hence the prefix "normal" is unnecessary.¹⁰ If "normal" means that the primary visual axes correspond, it is again unnecessary, since when other axes correspond the primary visual axis of one eye always corresponds to the axis that is regarded as primary in the other eye, at least for binocular vision. Although, so far as I know, all authors dealing with the subject have failed to define corresponding retinal points with explicit reference to corresponding visual axes, it is clear from the context of their papers that when they speak of retinal correspondence they at least mean that the correspondence is fixed. Since existence of corresponding visual axes is a normal characteristic, it constitutes the normal type of binocular projection. Since retinal

10. A patient with ordinary unilateral paralytic strabismus, who is otherwise normal with respect to the eyes, has retinal correspondence but abnormal binocular projection. The binocular projection, although of the normal type, is abnormal in that it is incorrect, but since the primary and other visual axes correspond, it is not anomalous.

correspondence exists only when there is correspondence of visual axes, it is the normal type of retinal correspondence. Hence correspondence of visual axes, normal type of binocular projection, retinal correspondence and normal type of retinal correspondence are synonymous terms. Of course, "type of" and "binocular" may be omitted when they are unequivocally implied by the context of an expression. For special purposes, the term normal retinal correspondence could be used to designate the condition in which the horopter closely agrees with some horopter, such as the Hering-Hillebrandt, assumed to be normal.

It may now be well to emphasize certain facts, obvious from the foregoing considerations. The precision with which a visual axis can be determined depends on the visual acuity of each eye and on the sizes of the two test objects and their distances from the eyes. If the distinctness of the images is disregarded, the nearer *C* (fig. 1) is and the farther *N*, the more precise the determination. Actually, however, the distinctness of the images cannot be disregarded. Practically, therefore, *C* and *N* must be of such sizes and placed at such distances as are suitable for the accuracy required. Anomalous projection is dependent on the existence of an interocular distance. As a mathematical concept, if this distance were zero, anomalous projection could not exist. When the test objects are all beyond a certain considerable distance from the eyes, the method described for determining anomalous projection is inapplicable, since the actual interocular distance is too small in relation to the visual acuity. When the test objects are at suitable distances, which are easily determined (usually about 10 cm. for near objects and 6 meters for distant objects), the discrepancy revealed by the test is either so slight or so great that correspondence or lack of correspondence of the visual axes concerned is at once apparent. Hence the distinction between retinal correspondence and anomalous projection is not relative but as nearly absolute as any subjective distinction can be.

From the evidence at hand, it seems safe to assume that to distinguish between retinal correspondence and anomalous projection it is simply necessary to ascertain either that the primary visual axes correspond within narrow limits or that they do not correspond within wide limits. This may easily be done by the method just described. If the primary visual axes seem to correspond within wide limits, this can mean only that the visual acuity concerned is too low for the observations to be of significance in regard to the type of projection. For this reason, in cases of high grade amblyopia it may be necessary to test some axis other than the primary axis of the squinting eye.

Another method for demonstrating anomalous projection is afforded by the subjective "cover test," commonly used for determining heterophoria. This is applicable in all cases of strabismus except the rela-

tively few in which the ocular deviation is less than about 20 prism diopters. This method is perhaps even simpler than that described, and when the results are positive it is equally conclusive. The squinter is asked whether or not an object which he is fixing at a distance of 5 meters or more appears to change its position or to move when a cover is quickly transferred from one eye to the other. If, as is usually the case, the object appears unchanged in position, anomalous projection obviously exists, for the primary visual axes do not correspond. This is also true if, as determined by a suitable prism, apparent change in the position of the object differs from the angle of strabismus by as much as 10 prism diopters. Owing to possible undetected fluctuations in the amount of ocular deviation, the method cannot be relied on to determine the nonexistence of anomalous projection or the existence of retinal correspondence. If in the rare case of a person without obvious squint but with anomalous correct projection marked strabismus should supervene as the result of trauma or paralysis, the cover test might fail to demonstrate the existence of the anomalous projection, since a prism that would compensate the actual deviation would also compensate the subjective deviation. Here the first-described method would be required.

For persons with normal vision, no change in the apparent positions of objects occurs with change in fixation, provided there is no change in convergence. This is true also of persons with anomalous projection; when the cover is transferred from the squinting eye, the object of chief attention continues to appear in its correct position whether or not it is then fixed by this eye. To the squinter the only significance of change in fixation by the squinting eye seems to be that he is "looking" with this eye.

To demonstrate perhaps still more clearly the fallacy of the usual concept of anomalous projection, a typical case of convergent strabismus may now be investigated as follows: Let the right eye fix a distant object, *A* (fig. 1). The primary visual axis of the left eye will intersect or nearly intersect that of the right eye at some point, *P*, determined by the angle of strabismus, which point for convenience may be designated the crossing point of the eyes. The position of this point varies to a greater or less extent with the accommodation and the distance of the object—facts that will be considered later. It will now be indicated by the cover test, and possibly also by the diplopia test and the nonius method, that *A* seems to be in the same place in space no matter from which eye it is seen. According to usual concepts, it must be assumed that the retinal points *F* and *A'* are corresponding points. But now substitute for *A* another object, *X*, anywhere on the line *AR* or its continuation. It is found that *X* also appears to be in the same place in space whether seen from the right or from the left eye. Moreover

it is never seen double. Therefore, also according to usual concepts, F and X' must be corresponding retinal points. And even when X is placed at P , it still appears to be in the same place when seen with the right eye as it does when seen with the left eye, and therefore the two foveas must be corresponding points. Thus, according to usual concepts, F must correspond to all retinal points in the left eye from y to F' , comprising the entire angle of strabismus. In other words, the retinal position of the false macula must vary through this wide range. Obviously this is an absurdity if it is assumed, as it always has been, that corresponding retinal points have fixed retinal positions. The truth is, as already explained, that in cases of anomalous projection there are no corresponding retinal points. As will be pointed out later, from a point of view not hitherto held, quasi corresponding retinal points may be said to exist in such cases. This demonstration also makes clear the inadequacy of the definition that corresponding retinal points are retinal points that are projected to the same place in space.

With the tests usually employed to determine whether "normal retinal correspondence" or "anomalous retinal correspondence" exists, an image is thrown on the fovea of one eye, and an image of a different kind, whether from the same object or not, is thrown on the other retina at the fovea or elsewhere. These conditions obviously are highly abnormal, since in eyes with ordinary vision every object in the binocular field is represented on both retinas and by similar images. Moreover, with most of these tests there are inadequate monocular criteria of distance in at least one eye. These unusual conditions may lead to uncertain, unreliable or inconsistent interpretations, particularly when there is anomalous projection. Thus when the test with the Maddox rod is used, the subject may state that the two images appear separated laterally, and yet much to his embarrassment he may be unable to state positively which is to the right of the other. With the after-image test strongly advocated by Bielschowsky,¹¹ and accredited by him to Hering, similar unusual conditions obtain, and criteria of distance are inadequate for each eye. With any of these tests, if two images, one on each fovea, appear to the subject to be superimposed or one directly behind the other, this does not conclusively prove the existence of retinal correspondence, for one or both of the images may be projected to the crossing point, whether or not the subject believes otherwise. However, if the two images are seen separated laterally in space, it is certain that the subject is manifesting anomalous projection, but the amount of the apparent separation, however measured, is not a reliable indication of the accuracy of the projection under usual conditions.

11. Bielschowsky, A.: (a) Application of the After-Image Test in the Investigation of Squint, *Arch. Ophth.* **17**:417 (March) 1937; (b) Untersuchungen über der Sehen der Schielenden, *Arch. f. Ophth.* **50**:406, 1900.

In this connection it is to be noted that instruments such as the stereoscope, including the haploscope and the amblyoscope, introduce conditions so abnormal that the results obtained with their use are often difficult to interpret or to correlate with the ordinary visual phenomena of normal persons or of squinters. In general, it is safe to say that the simpler the means employed in the investigation of visual functions, the more reliable are the results. It will no doubt be evident that in my own investigations I have endeavored to adhere to this principle.

A common assumption, which I believe to be erroneous, is that a distinction between alternating and nonalternating strabismus is of fundamental importance.¹² I have found that almost all persons with concomitant strabismus in whom neither eye is so amblyopic that it is incapable of central fixation can be taught in a few moments to alternate. It is simply necessary while the subject is viewing a distant object to cover one eye and then the other and at the proper time to say, "Now you are looking with the right eye, now with the left." After this has been repeated a few times, often only two or three, the subject can fix with either eye at command while keeping both eyes open and can also correctly designate the fixing eye. How he does this, he is unable to describe. When the object of fixation is at the crossing point, the subject may be unable to designate the eye with which he is fixing or may state that he is looking at the object with both eyes. Occasionally a squinter also makes the latter statement even when the object is at a distance. A person who has acquired the habit of ascertaining with which eye he is "looking" only by closing one eye is difficult to teach to alternate, for after many attempts he may still persist in closing one eye when asked to designate the eye with which he is "looking" or when asked to "look" with one or the other eye. When the angle of strabismus is slight, it may also be difficult to teach alternation. Whether or not a squinter naturally alternates no doubt depends chiefly on the extent to which the efficiency of one eye exceeds that of the other. However, alternation is probably of real importance in preventing amblyopia and also possibly of importance in protecting one eye from occasional peculiarities, for instance unilateral nystagmus,¹³ which might ensue were this eye continually deviated.

12. L. C. Peter (Extra-Ocular Muscles, Philadelphia, Lea & Febiger, 1936, p. 208) tabulates five criteria which, he contends, set apart "essentially alternating strabismus" as a distinct class. These criteria do not seem sufficiently definitive to sustain his classification. The assumption that in general the earlier in life strabismus is established the more difficult it is to induce normal ocular relations seems to explain his inability to obtain or develop "fusion" in the cases concerned and also to be more reasonable than his contention.

13. Verhoeff, F. H.: A Case of Unilateral Nystagmus Benefited by Treatment, *Ophth. Rec.* 16:517, 1907.

A prevalent misconception is that the squinting eye ordinarily plays no part in vision, except possibly outside the binocular field, but constantly "suppresses" the retinal images from all objects in the binocular field. Thus Bielschowsky⁸ recently stated: "In the latter case [normal correspondence] the suppression prevents diplopia, whereas in the former [anomalous correspondence adapted to the angle of squint] it prevents the advantage that would be gained by the anomalous correspondence." That this advantage is not prevented and that the squinting eye plays an important part in binocular vision I have demonstrated by the following four tests, which I have employed in many cases of strabismus, convergent and divergent:

The first test, which is also another simple and conclusive test for anomalous projection, I have thus far used only in cases in which the visual acuity was not below 0.5 in either eye. A small letter, *A*, is drawn on a small piece of white cardboard. This is held beyond the crossing point¹⁴ at any convenient distance, and the subject is told to look steadily at it and not to look elsewhere. A different letter, *B*, of the same size, on another piece of cardboard, is now placed at the same distance away and approximately in the primary visual axis of the squinting eye. It is moved about until the subject says he sees it most distinctly. He is then able to name it. If the squinting eye is now covered, the *B*, or a different letter substituted for it, is no longer legible. The squinter, with both eyes uncovered, when asked to state with which eye he is seeing *B* usually designates the nonsquinting eye. If he is asked if he is seeing both letters simultaneously, he answers in the affirmative. If he is asked if the two letters appear the same distance apart, or nearly so, when seen with either eye alone or with both eyes open, he also answers in the affirmative, thus affording further evidence that in such cases an object appears in the same place no matter from which eye it is seen. If he has learned to alternate or has been taught to do so as described here, similar results are obtained when either eye is used for fixation.

With the foregoing test, the squinter in a sense is fixing with both eyes, although on a different object with each eye. Yet he will state that he is "looking at" *A*, not at both *A* and *B*, whether or not he is able to designate with which eye he is doing so. Another significant fact is that when his attention is called to *B*, he manifests a desire, which is sometimes irresistible, to fix it with the nonsquinting eye. However, if he has learned to alternate and is requested to look at *B* with the squinting eye, he promptly does so, as is evidenced by a slight ocular movement when this is necessary to center the image of *B* on

14. In a case of divergent strabismus, of course, the crossing point of the primary visual axis is an imaginary point situated behind the eyes.

the fovea of this eye. Incidentally, from these observations it is obvious that the fixing eye cannot always be determined by asking a squinter with which eye he is "looking." The simplest way to ascertain this is to ask him to designate the object at which he is looking, and then for the observer to note which eye is directed toward this object. Objectively, the fixing eye can be determined by ascertaining on which fovea movement of the image causes movement of fixation.

With the second test, which consists simply of application of the first test to areas other than the foveas, fixation is steadily maintained on any convenient object. Another object, for instance the letter *B*, is carried across the binocular field, and at suitable intervals comparisons are made as to the apparent distinctness of this object, or its legibility, and its apparent position when seen in binocular vision and when seen from each eye separately without change in fixation.

The third test, employed to show that in cases of strabismus both eyes play an important part in vision, is equally simple. A red transparent screen is placed before the fixing eye, and a green transparent screen, before the other eye. The subject is instructed to maintain fixation on a small object situated at a distance of about 1 meter and usually, therefore, well beyond the crossing point, even if the strabismus is convergent. A white disk, 21 mm. in diameter, on a black background is now placed just above or to one side of the point of fixation. To the subject it appears red. It is then placed on the primary visual axis of the squinting eye at about the same distance away. Now it appears green. It is then slowly carried across from this position toward the other. When at an intermediate position, while still appearing to be the same object seen with the same eye, it suddenly appears red, without sudden change in its apparent position. Evidently the position at which it appears to change color indicates the line which at the time divides the visual field seen by one eye from that seen by the other. In no case did the statements of the squinter indicate that there was binocular mixture of colors, even when the disk was placed at the crossing point. When the disk was placed there, it was never described as yellow, although rivalry in colors sometimes occurred. However, it should not be inferred that binocular mixture of colors is impossible for persons with strabismus, for this phenomenon is often difficult to demonstrate even in normal subjects. In some cases of strabismus Bielschowsky^{11b} obtained the appearance of violet from red and blue when the test object was far beyond the crossing point.

The fourth test affords an interesting demonstration of the part played by the squinting eye in binocular vision under abnormal conditions, a part similar to that played under the same conditions by the normal eye. The test is carried out by the aid of an ordinary stereo-

scope from which the median partition has been removed so as to permit each eye to see both fields. If through such an instrument a normal person views a stereoscopic card on which are two similar circles, one centered before the right eye and the other centered before the left eye, he will see three circles: a middle circle unified by the two eyes and on each side of it a circle seen monocularly. A squinter also usually thus sees three circles, except that the middle circle is consciously seen from the fixing eye only. If the fixing eye is the right eye and the circle on the right is red and that on the left green, the squinter will see a red circle in the middle, a red circle on the right and a green circle on the left. For the normal subject, the middle circle will show rivalry between red and green or will appear yellow. From the results of the foregoing tests the following conclusions can be drawn concerning the vision of squinters with anomalous projection:

1. Ordinarily both eyes are used in binocular vision.

2. Usually in binocular vision each object is consciously seen only from the eye from which it could be the more distinctly seen in monocular vision without change in fixation. This means, of course, that as a rule when the two eyes are nearly equal in visual acuity the eye from which an object is consciously seen is the eye whose retinal image of the object is nearer the fovea. This rule applies also when the squinting eye is highly amblyopic, except in the case of objects whose retinal images in the squinting eye fall within the amblyopic area. Of course, the rule may not hold when by artificial means the two images of an object are given decidedly different attention values, for instance, when to one of the images is imparted motion, flicker, color or an intensity different from that of the other image. No doubt there are other special or highly unusual conditions under which the rule may not hold.

3. Whether or not there is amblyopia, there are in each eye certain large retinal areas the images from which are constantly replaced in ordinary vision.

4. To the squinter, all retinal images simultaneously presented that are consciously seen appear to be seen simultaneously, no matter to which eye any of these images belongs. Hence an image on one fovea and another image on the other fovea appear to be seen simultaneously even when, as is ordinarily the case, they appear separated laterally in space and each is completely seen. (The special case of an object situated at the crossing point will later be considered at length.)

5. The squinter reacts as if, and will usually state that, each object in the binocular field is seen from the fixing eye only, no matter from which eye it is consciously seen.

It is as difficult for a person with normal binocular vision to imagine some of the visual phenomena of the squinter as it is for a color-blind

person to imagine the appearances of colors. For instance, a normal person cannot imagine any conditions under which it could be impossible to determine which of two images seen horizontally separated was to the right of the other, yet under certain artificial conditions the squinter is unable to do this. Nor can a normal person imagine that two images, or after-images, one on each fovea, under any conditions could be simultaneously seen as if separated laterally in space. As a matter of fact, a normal person actually can see completely two such images as if separated laterally in space, but he cannot simultaneously thus see them. For example, he can fix an object, *A*, with the right eye alone, and then an object, *B*, at one side of it, with the left eye alone. Under these conditions, *A* and *B* appear to remain unchanged in position, as they actually are, but the subject is aware that they are not seen simultaneously, that the apparent distinctness of each letter has changed and also that he has moved his eyes. In the case of a squinter with the image of *A* on one fovea and that of *B* on the other, *A* and *B* appear to be seen simultaneously without movement of the eyes and with unchanging distinctness. It is evident that before an attempt is made to understand the visual phenomena peculiar to the squinter it is necessary to disabuse the mind of many notions derived from a study of normal binocular vision. Failure to do this has led to misconceptions.

There is no more reason to doubt the statement of a squinter that two images, one on each fovea, are seen simultaneously as if from the fixing eye alone than to doubt the statement of any person that two separate images actually in the same eye are seen simultaneously. At present there is no evidence to disprove either statement. Nevertheless, regardless of these impressions of the squinter himself, it has been assumed that images on the two foveas are not actually seen simultaneously.¹⁵ This assumption gives rise to a conception of the vision of the squinter that at first may seem to be simple and satisfactory; this is, when certain images are seen from one eye, the images that would correspond to them in the other eye if there were retinal correspondence are completely replaced, and alternating replacement of one image by the other occurs with such rapidity and frequency that the time intervals concerned are not perceived. There is evidence that complete replacement can normally occur with this rapidity, at least as regards small retinal areas, but none that it can ever occur with this frequency. And to explain why every object is seen in its correct position, no matter from which eye it is seen, and also why the squinter believes that he is seeing from one eye alone, it is necessary to assume as occurring coincident with each replacement an equally rapid and

15. Javal, E.: *Manuel théorique et pratique du strabisme*, Paris, G. Masson, 1896, p. 277.

consciously unperceived change in the correlation of the sensory with the unchanged ocular motor mechanism. The conception would seem to require that each object one image of which is on or near one macula and the other image of which is at a distance from the other macula be seen distinctly and then very indistinctly in rapid alternation and that this should give the object a blurred appearance. Thus the conception, on further consideration, requires so many unsupported and complex assumptions that it becomes unreasonable.

Not only does the squinting eye play an important part in binocular vision, but it provides certain advantages not possessed by the normal person. All squinters with anomalous projection, except those with amblyopia, make simultaneous use of two regions of distinct macular vision in the binocular field beyond the crossing point, and even when the squinting eye is highly amblyopic they have abnormally high visual acuity in certain portions of the field toward which the squinting eye is directed. In cases of divergent strabismus the outer field is, in addition, enlarged on the side of the squinting eye, so that objects approaching from this side must be seen sooner and more distinctly than by the person with normal vision. In cases of convergent strabismus of ordinary degree, I have ascertained that each blindspot is replaced by an image that is abnormally distinct. This is so because the replacing images are abnormally near the foveas. As will be obvious later, the squinter does not have to contend with physiologic diplopia. The effort and fatigue associated with the complicated function of binocular fixation are entirely lacking. It is probable that these advantages often offset the lack of delicate binocular depth perception. However, they do not often offset the disadvantages of the associated cosmetic defect or in cases of amblyopia compensate for the lack of a reserve eye with good central vision.

Since the term anomalous as applied to binocular projection refers only to the type of projection, it carries no implication as to the correctness of the projection. Obviously there may be anomalous correct or anomalous incorrect projection, depending on the correctness of the monocular projection. I find that usually in cases of anomalous projection, even when the squinting eye is amblyopic, the projection is substantially correct. Thus I find that if while the nonsquinting eye is fixing a convenient object another object is so placed before the squinting eye as to be seen more distinctly with both eyes open than with the fixing eye alone, and then a median partition is placed so as to exclude the second object from the fixing eye only, the two objects appear in about the same relative positions as they do when the partition is removed and also as they do when both objects are seen with the fixing eye only.

It is evident in a case of anomalous correct projection that from each eye used alone all images are projected with respect to each other

and with respect to the eye itself as correctly as monocular criteria of depth permit. If such projection were maintained when both eyes were in use, objects would be seen from two different points of view at one time, all approximately in their correct positions. This may seem impossible, yet if it did occur it would probably be no more difficult to explain than the familiar fact that when both eyes are occluded one object touched by the two hands is ordinarily correctly perceived as one object in one place. What actually happens in cases of strabismus, whether or not the projection is correct, is that the apparent absolute positions of all images that reach consciousness from the squinting eye are determined by the projection of this eye, while their apparent relative positions are judged from the point of view of the fixing eye. Although it is difficult to understand how such localization can be accomplished, that it is accomplished can be easily verified by asking the subject to define the relative positions of various objects. For example, in a case of anomalous relatively correct projection, let the right eye fix the distant object, *A*, and place *H* so that as seen from the left eye it appears in line with and just below *A* when the right eye is occluded (fig. 1). Then with both eyes open and *H* excluded from the view of the right eye by a median partition, *H* appears no longer in line with but to the left of *A*, as if *H* were being seen from the right eye only. If in a case of divergent strabismus the effect of incorrect projection is now produced by placing a suitable prism, base in, before the left eye, *H* is seen from the left eye only and still appears to the left of *A*, even when *A* is seen from this eye. To insure *A*'s being seen from the left eye, it may be necessary to employ a suitably placed screen. In a case of convergent strabismus, with the prism base in it may be impossible, owing to the indistinctness of the retinal images, to insure *A*'s being seen from the left eye even by means of a screen, but *H* appears to the left of the new position of *A*, estimated from the strength of the prism.

In the case of retinal correspondence, monocular depth criteria (such as size) have nothing to do with determining the direction of any monocular or binocular visual axis, that is to say, with determining the apparent angular direction of any object. In the case of anomalous projection, however, monocular depth criteria derived from the squinting eye, even when binocular criteria are removed by means of a suitable screen, can determine the apparent direction of an object as seen from only that eye in binocular vision. As concerns any object well within the binocular field, the visual axis of a retinal image in the squinting eye intersects innumerable visual axes of the fixing eye. To which of these intersections the image is projected, and hence in binocular vision along which axis of the fixing eye it is projected, monocular depth criteria derived from the squinting eye can determine. Thus whether *A* and

B (fig. 1) are projected to their actual locations or to the crossing point *P* can depend solely on monocular depth criteria. This analysis reveals one of the fundamental distinctions between the projection of a person with fixed retinal correspondence and that of a person with anomalous projection. The possibility that "suppressed" retinal images may play a part in determining the accuracy of anomalous projection will be considered later.

As already indicated, it is commonly believed or implied that "suppression" or, as I have termed it, replacement,¹⁶ is an unusual or abnormal phenomenon and one that is manifested especially by the squinting eye. As a matter of fact, without it every normal person would see double all objects other than the relatively few that lie on the horopter. By many it is believed that when both eyes are open the entire binocular portion of the visual field of the squinting eye is "suppressed" by this eye. That this is not so and that "suppression" ordinarily occurs in both eyes simultaneously are clear from the fact, already pointed out, that both eyes simultaneously play an important part in vision. It is even maintained that one of the important steps in developing "fusion" is teaching "simultaneous macular perception," that is to say, "teaching the macula of the squinting eye not to 'suppress.'" Presumably by "fusion" is meant binocular fixation, and I¹⁶ have pointed out that in normal binocular vision this ordinarily takes place while one of the retinal images concerned is completely suppressed. If by "fusion" is meant the seeing of two images as one image, then it is to be said that "suppression," partial or complete, instead of being disadvantageous is essential to this process.¹⁶ Whether or not simultaneous macular perception could be demonstrated in a person with ordinary vision by means of an instrument such as the amblyoscope, it certainly existed in all of the many persons with strabismus without marked amblyopia on whom I employed the "A and B test." In such persons the real abnormality consists not in lack of simultaneous macular perception, for there is no such lack, but in the facts that both images are seen completely and that ordinarily one is seen laterally separated from the other in space.¹⁷

16. Verhoeff, F. H.: A New Theory of Binocular Vision, *Arch. Ophth.* **13**:151 (Feb.) 1935.

17. Many of the assumptions on which orthoptic training is said to be based no doubt appear fallacious to those who, from a purely scientific and also from a practical point of view, have given years of consideration to the subject of binocular vision. These assumptions include those discussed in the present communication. Yet because the methods employed may be based on false premises, it does not necessarily follow that they are without value for the purposes intended. Their real value can be ascertained only by a truly scientific analysis of the results obtained.

It has always been assumed that "suppression" in cases of strabismus in which there is anomalous projection is the same process as the "suppression" which occurs when there is fixed retinal correspondence. When "suppression" is said to occur in a person with normal vision, what is actually taking place is the process I have termed replacement.¹⁶ Replacement implies that when an image from one eye disappears from consciousness the image from the corresponding retinal area in the other eye is sent to consciousness; when an image from the macula of one eye is replaced, the image seen instead is always that from the macula of the other eye. When replacement is partial, as it often is, one retinal image is seen to the same extent that its corresponding image is not seen. In cases of strabismus ordinarily the images on the two maculas are from two different objects, and when there is good central vision in each eye neither image is "suppressed," whereas both of the other two retinal images of these objects are completely "suppressed" and moreover occupy different retinal positions under different conditions. Except possibly when an object is situated at the crossing point, "suppression" in cases of strabismus is always complete. Since, in general, the positional relations of the retinal areas concerned in "suppression" in cases of strabismus are variable and entirely different from those concerned in replacement, it is evident that the nervous connections involved in the two processes are also different. For objects beyond the crossing point, "suppression" analogous to the replacement which explains binocular luster,¹⁶ and possibly also binocular color mixture in a normal subject, has never been demonstrated in a subject manifesting anomalous projection. In view of these important facts, it is clear that "suppression" in a person with anomalous projection differs fundamentally from that occurring in a person with normal vision. I shall therefore designate it by the term *quasireplacement*.

In this connection it should be borne in mind that even when not consciously perceived, stimuli from a retina are normally subconsciously effective somewhere in the brain. For certainly, as I have shown elsewhere,¹⁶ replacement of one of a pair of disparate images does not prevent their producing appropriate depth effect, even though the replacement is so complete that the subject is unconscious of the existence of the replaced image and by no effort of will can see it. It is perfectly conceivable that under certain abnormal conditions the subconscious effectiveness of a retinal image might be abolished in certain respects, whether or not the image was consciously perceived. This, of course, is known actually to be true for the reactions of the pupils to light. In addition to the quasireplacement associated with anomalous projection, it is therefore necessary also to distinguish from replacement

suppression of a still different kind, operating as an abnormal process at a lower level. This process I shall term subconscious visual suppression. "Replacement," because it indicates a normal process, cannot be properly used as a substitute for "suppression" in this term.

The process of replacement provides for corresponding retinal points a definition different from that already described and also different from any definition hitherto employed. Owing to this process, an image from a retinal area in one eye partially or wholly obscures an image from the corresponding retinal area in the other eye and under no conditions ever obscures the image from any other retinal area. Thus in binocular vision a distant object can obscure the view of a near object. (As a matter of fact, it can also do this in monocular vision, for instance, when a distant object is viewed through a transparent picture.) Hence corresponding retinal areas may be defined as any two retinal areas so related, under all conditions only to each other, that an image from one area always partially or wholly obscures an image from the other. This definition does not conflict with that previously given and, as will be obvious later, is of considerable value in connection with the question of diplopia. It is also of value in the determination of corresponding retinal points, but it is of no value in determining the nonexistence of retinal correspondence, that is to say, in determining the existence of anomalous projection, because when obscuration is complete, as it always is in cases of anomalous projection, except possibly for objects in a surface passing through the crossing point, and as it may be in cases of retinal correspondence, the image that is obscured cannot be identified. Since obscuration is thus always complete in cases of anomalous projection, the simple demonstration that two retinal images either of which is projected considerably beyond or nearer than the crossing point partially obscure each other suffices to prove that the retinal areas on which the images lie are corresponding retinal areas.

In cases of anomalous correct projection, the cover test shows that each object situated beyond the crossing point appears to maintain the same absolute position when alternately seen from one eye and then from the other. Hence the two retinal images of the object correspond in the sense that each is projected to the same place in space. From a theoretic standpoint, therefore, it can be assumed that in binocular vision, although one of the images is not then consciously seen, the retinal areas on which they lie correspond temporarily. The reason why one image is not seen may be assumed to be that it is completely obscured by the other, so that theoretically the areas also correspond temporarily on the basis of obscuration. But since when an object is moved along a monocular visual axis of one eye the position of its retinal image in the other eye constantly changes yet the two images

continue to correspond as before, it is evident that the retinal correspondence in question is not fixed but variable. However, as it concerns all objects beyond a certain considerable distance it can be said to be fixed.

Such retinal correspondence differs essentially from true retinal correspondence not only in its variability but in at least one other important respect, namely, that the visual axes of the assumed corresponding retinal points do not correspond. Hence it is obligatory that it be designated by a term that unmistakably distinguishes it from true retinal correspondence. I shall therefore designate it quasi retinal correspondence. Anomalous projection can be defined as a type of binocular projection in which there is quasi retinal correspondence. This definition, however, offers no practical advantage over that previously given, since it suggests no method of demonstration simpler or more conclusive than that required for demonstrating correspondence or lack of correspondence of visual axes.

The extreme delicacy of binocular stereopsis indicates that the brain can make even finer discriminations between disparate retinal points than it can between different points in the same retina. The subjective cover test also indicates fine discrimination between disparate retinal points, since in cases in which there is retinal correspondence it elicits apparent motion of the object of fixation with deviations of a small fraction of a degree. As pointed out previously, for objects all beyond a certain considerable distance from the eye quasi retinal correspondence in a case of anomalous correspondence is, in a sense, fixed. But with the cover test, in a case of anomalous projection the strength of the weakest prism that will produce apparent change in position, or apparent lateral motion of a distant object, is never less than about 6 prism diopters and is sometimes 20 prism diopters or more. This poor discrimination, since it is not confined to persons with strabismus of sufficiently high degree, cannot be explained by the low visual acuity of the peripheral retinal area concerned. Hence the subjective cover test reveals another important difference between retinal correspondence and quasi retinal correspondence. This difference would seem to be adequately explained by assuming that quasi retinal correspondence is dependent on correlation of motor factors with retinal position and other monocular criteria, whereas retinal correspondence is dependent on retinal position alone. On the basis of the poor discrimination revealed by the cover test in cases of quasi retinal correspondence, it cannot be inferred that the apparent angular separation of two simultaneously presented distant objects one of whose consciously perceived images is on one fovea and the other on the other fovea is judged with an inaccuracy of at least 6 prism diopters. As a matter of fact,

actual tests show that the inaccuracy is far less than this, for the objects appear the same angular distance apart as when seen simultaneously from one eye alone.

Intimately related to questions that arise in connection with the foregoing observations is the following phenomenon: With the objective cover test, when a prism is used which partly or wholly compensates the squint it is usually found that when the cover is transferred from one eye to the other the uncovered eye before achieving exact fixation of the test object makes a movement as if the squint had been considerably overcorrected. The phenomenon can often be observed also without the use of a prism in cases in which the squint has been recently corrected or reduced by operation. While no doubt this phenomenon is generally familiar, its possible significance seems to have been overlooked. The uncovered eye makes an anticipatory movement as if it expected to find the object in the same place in which it had been seen by the other eye and had sought for the object here before becoming aware of the change, produced by the prism or by the operation, in its position relative to the eye. The phenomenon may occur even when the change in position is not consciously perceived, that is to say, when it is only subconsciously perceived. It is clear that the phenomenon accords with the fact that in cases of anomalous correct projection objects simultaneously presented appear located correctly in space no matter from which eye they are seen. It is also clear that the phenomenon indicates the existence of intricate and relatively precise correlations among the sensory mechanisms of the two eyes and the conjugate ocular motor mechanism. Obviously the phenomenon affords strong evidence of the existence, or previous existence, of anomalous projection.

The term *diplopia* is regarded as synonymous with double vision and is commonly defined as the seeing of one object as two objects. It seems to me this definition is inadequate and that two types of *diplopia* should be distinguished, which may be termed *disparate* and *corresponding diplopia*. They may be demonstrated to a person with normal binocular vision by having him look at a distant textured wall and then hold a finger a short distance in front of his eyes. He may then see two fingers and through each finger a portion of the textured wall. Seeing the single finger as two fingers is *disparate diplopia*; seeing the textured wall through one finger is *corresponding diplopia*. Another demonstration of *corresponding diplopia* is afforded by the "bar reading test." In this type of *diplopia* there is double vision in that two different images on corresponding retinal areas are seen simultaneously, partially obscuring each other. These two types of *diplopia* may be defined as follows:

Disparate diplopia is simultaneous visual perception of two retinal images that do not appear to obscure each other and that actually originate from the same external spatial area, or that are so interpreted.

Corresponding diplopia is simultaneous visual perception of two retinal images that appear partially to obscure each other.¹⁸

It would seem that these definitions are sufficiently exclusive and yet include all visual phenomena that may be usefully classified as diplopia. Of course, no definition can be more than relatively perfect.

Disparate diplopia includes not only the seeing of one object as two objects but other phenomena not ordinarily thought of as diplopia. Thus it includes such phenomena as seeing during the Maddox rod test a small round light and a streak of light, both actually originating from the same light source, and also the visual phenomenon elicited when through the use of a stereoscope two actual objects each seen with only one eye are interpreted as one actual object seen as two. Corresponding diplopia includes the seeing of two different objects one behind the other when they are not actually so situated with reference to either eye or to any point between the eyes. It also includes seeing one object whose retinal images have been made different by artificial means as two objects one behind the other. No doubt corresponding diplopia often causes the afflicted person as much "abhorrence" as, if not more than, does disparate diplopia, to which the term diplopia is generally restricted. Often both types of diplopia occur at the same time. In cases of anomalous projection disparate diplopia often may be easily elicited by the use of prisms and may occur after operation, but it seems impossible that corresponding diplopia could ever occur except under artificial conditions.

With one exception, it can be said that in the squinter with anomalous correct projection, diplopia analogous to physiologic disparate diplopia never occurs in the absence of binocular fixation. Thus when the squinter looks at a distant object while holding a finger before his eyes, he never sees two fingers. The exception to this is the case of a convergent squinter without amblyopia who is fixing an object placed nearer than the crossing point. Here the squinter often observes disparate diplopia of the object. The explanation of this would seem to be that the squinter is subjected to conditions which he is unable correctly to interpret, owing to the lack of sufficient experience, since one image of the object is to the outer side of the other fovea. For the divergent squinter,

18. It is to be noted that these terms and definitions apply as well to monocular as to binocular diplopia. Objection may be raised to them on the grounds that diplopia has hitherto meant only what I have described as disparate diplopia. The same objection could be made to the terms light water and heavy water, but it is now generally recognized, at least among scientists, that the unmodified term "water" is insufficiently descriptive.

retinal images so situated do not cause diplopia, because they have such positions for all objects to which he directs his attention, and hence his experience is adequate for correct interpretation of the images. In other words, for the divergent squinter an object cannot be placed nearer than the crossing point, because this point is behind the eyes. However, if a divergent squinter can fix a near object binocularly, when doing so he may observe physiologic disparate diplopia of a distant object even though he is still manifesting anomalous projection.

As already indicated, usually before operation, in a case of strabismus in which there is anomalous projection the projection is as nearly correct as the monocular criteria could permit. After operation, especially if binocular fixation is still absent, the anomalous projection persists and for a time is incorrect, since objects as seen with the eye which has been operated on appear incorrectly located. It would be expected that during the period of readjustment there would be conflict between the old projection and the projection that is being newly acquired. That this is actually so is indicated by the fact that if the various tests described here are employed a few months after operation the results obtained in some cases are so inconsistent that they are difficult if not impossible to interpret. As would also be expected, after operations for strabismus there may be postoperative disparate diplopia, which occasionally is highly annoying and in rare cases is of long duration, even permanent. Before operation, except in the unusual case of an object situated at the crossing point, images on or near the fovea of each eye are from different objects, and are all completely seen with non-amblyopic eyes with anomalous projection. Hence after an operation which corrects or nearly corrects the squint, when there is an image on the fovea of the fixing eye and an image of the same object on or near the fovea of the other eye, both images are seen for a time. Their apparent distance apart is determined by the apparent distance of the object from the original crossing point of the eyes and by the degree of the original squint. For similar reasons, other objects may also be seen double. In unusual cases there may be postoperative disparate triplopia and even monocular disparate diplopia. No doubt these are usually due to persistence of the old anomalous projection, now incorrect, along with the development of new and correct projection. Permanent postoperative disparate diplopia and triplopia seldom if ever occur in young children, no doubt because the anomalous projection has not become well established before operation and because children readily adapt themselves to new conditions. That these phenomena are rare even when the operation is performed relatively late in life shows that a person with strabismus who is otherwise normal can readily alter his projection. The fact that a few squinters cannot thus adapt themselves indicates that they are abnormal not only in having strabismus but also

in some other respect. Inability to adapt themselves to new conditions is a characteristic of persons with psychoneurosis, and, as a matter of fact, I have observed that many persons with persistent postoperative disparate diplopia have obvious psychoneurotic tendencies.

The question of amblyopia now arises. The statement that amblyopia is a frequent cause of strabismus is undoubtedly true. The statements that strabismus is a cause and that it is a frequent cause of amblyopia are still disputed, but I shall accept both as true. Amblyopia resulting from strabismus is generally believed to be due to long-continued "suppression" of images from the squinting eye. It has been assumed, no doubt correctly, that at the onset of the strabismus there is diplopia, or at least visual confusion, which is soon overcome by "suppression." If the "suppression" is continued, it is believed to cause amblyopia. In the cases in which amblyopia does not occur, it is assumed that constant "suppression" has been prevented by alternation or that its duration has been short, owing to early development of anomalous projection. In favor of this hypothesis is the fact that in many cases the amblyopia is largely abolished by long occlusion of the "good" eye. The amblyopia involves the macular region of the squinting eye and sometimes also the region within which the image of the object of chief attention usually falls. Obviously, as concerns the object of chief attention, "suppression" in both regions would do away with the two types of diplopia defined previously. The hypothesis, however, presents three difficulties. The first of these is that to overcome diplopia of all objects in the binocular field "suppression" (replacement) could not be limited to the two retinal areas mentioned. The second difficulty is that even when amblyopia has been prevented and anomalous projection established, "suppression" (now really quasireplacement) of the images in certain large retinal areas continuously occurs without causing amblyopia of these areas. The third difficulty is in assuming that either the normal process, replacement, or quasireplacement could cause amblyopia. Certainly the latter could not do so, since it continually occurs in cases in which amblyopia is not present. These difficulties are overcome by the assumption that amblyopia is caused by neither of these processes but by subconscious visual suppression. This assumption is strongly supported by the frequently observed facts that at the onset of squint the child does not complain of diplopia yet has some vague visual disturbance, as indicated by frequent closure of the squinting eye. This is sometimes true even in the case of paralytic squint occurring in an older person. The patient may say that he has no diplopia yet state that he has well marked visual disturbance. In general, visual disturbance resulting from strabismus is due to disparateness of images which under normal conditions would not be disparate and to an abnormal degree of disparateness of all other images. If both of any two disparate

images are consciously perceived, there is diplopia. In the case of the squinting child and also in the case of the older person referred to, the diplopia has been overcome by replacement, and the remaining visual disturbance must be attributed to the continuing subconscious effects of the replaced images. If this disturbance disappears in turn, it is reasonable to suppose that its disappearance is due either to the development of anomalous projection or to suppression of the subconscious effects of the images from the squinting eye, that is to say, to subconscious visual suppression. When this occurs, it, instead of replacement, is assumed to abolish the conscious perception of the images. If this abnormal suppression soon becomes unnecessary because of the development of anomalous projection, it ceases entirely and amblyopia does not result. On the other hand, if the subconscious visual suppression is not frequently interrupted by alternation or is not soon made unnecessary by anomalous projection, the suppression persists in some degree even in monocular vision and there is amblyopia of the squinting eye. The fact that amblyopia does not occur in cases of paralytic squint, even in the unusual cases in which the vague visual disturbance disappears in spite of the lack of anomalous projection, perhaps is explainable on the assumption that subconscious visual suppression is not persistent in older persons because their nervous systems are relatively stable. Conversely, disregarding the factors of anomalous projection and alternation, the earlier the onset of concomitant squint, the more likely amblyopia will result. The varying extent to which amblyopia is overcome by the development of anomalous projection, or can be overcome by occlusion of the better eye, may be accounted for by variability, dependent largely on age, in the degree of persistence of subconscious visual suppression or by actual injury which this abnormal process may cause to the visual mechanism.

The usual theory as to the cause of the amblyopia associated with strabismus is often expressed by the term amblyopia from disuse—amblyopia ex anopsia. Since it is believed by those who hold this theory that disuse of the squinting eye means normal "suppression," this method of expressing the theory is really no different from saying that "suppression" is the cause of amblyopia. This theory postulates that loss of vision is due merely to persisting suppression of the activity of the visual sensory mechanism of the squinting eye, with resulting injury to this mechanism. The theory that I have just advanced postulates that it is not this suppression per se but persistence of an abnormal subconscious process which causes it that produces amblyopia.

The question may be asked, How can visual images not consciously perceived cause visual disturbance? The answer is that such images normally send valuable information which consciousness accepts and acts on, and hence when this information does not accord with other infor-

mation, it causes confusion. If it is then asked in what respects and to what extent the information furnished by the images just considered does not accord with other information, the answer is that the information they furnish is greatly at variance with that supplied by the correct monocular criteria from the fixing eye, if only because it indicates that the objects from which the images originate are situated at distances which differ greatly from those indicated by the monocular criteria. In the case of convergent strabismus it indicates that the former distances are much greater than the latter; in the case of divergent strabismus it indicates that they are much less than the latter. Moreover, the subconscious information indicates that in the first case less and in the second case more accommodation is required to make the objects distinct than consciousness actually finds necessary. It seems probable that the visual disturbance resulting from all of this conflicting information due to images not consciously perceived is more unpleasant and more likely to cause symptoms, such as nausea, than mere diplopia of images that are consciously perceived. Diplopia if not associated with this conflicting information might be regarded by the affected subject as a pleasing and interesting phenomenon were it not for the difficulty in deciding which of two similar objects was the real object and were he not aware of the possible serious portent of the phenomenon. As a matter of fact, physiologic diplopia is generally so regarded.

As is well known, in certain cases of amblyopia the amblyopic eye employs for monocular vision an eccentric retinal area which in binocular vision seems to be roughly adapted to the angle of squint. In some cases the visual acuity of this area is higher than that of the real macula, and it has even been assumed that it may be abnormally high for such a portion of the retina. If this assumption is true, it goes to show that quasireplacement may even enhance visual acuity. An eccentric retinal area used for monocular fixation can in a sense be regarded as a false macula. But as regards binocular vision, it does not accord with the common conception of a false macula, for it does not under all conditions "correspond" with the real macula, or, in fact, with any fixed retinal area in the other eye.

The function of convergence is always an important factor in cases of strabismus, and in many cases of convergent squint associated with hypermetropia it undoubtedly has been the most important causative factor. After strabismus has been established, the function persists, although it is then evidently valueless and perhaps even detrimental to the accuracy of projection. The function of accommodation seems to be inextricably associated with what is called voluntary convergence as distinguished from adduction and abduction. In some cases of strabismus accommodation is associated with an abnormally great, and in others with

an abnormally small, amount of convergence. Normally, the sense of nearness, however produced, causes some convergence, even when the need of accommodation is abolished by means of convex glasses, and this seems to be true also in some cases of strabismus. To what extent, if any, the function of convergence impairs the accuracy of projection in cases of strabismus I have not determined.

There now arises a question, possibly of considerable importance, which has already been touched on. This relates to the conscious perception of an object placed at the crossing point in the case of a convergent squinter with anomalous projection correct for this spatial position. Obviously the conditions here are similar to those existing for a person with binocular fixation who is in the same position as the squinter and is fixing the object. The question is, under these conditions, whether in the case of the squinter replacement similar to that of a normal person occurs. I have attempted to answer this question by the aid of a contrivance that I call a replacement tester. In the center of a piece of white cardboard, about 10 cm. square, is cut a circular hole, 14 mm. in diameter (fig. 2). Extending backward from the middle of the hole is a vertical partition, about 18 cm. long, the right side of which is red and the other side of which is green. Perpendicular to the partition and attached to the distal end of it is a black screen, about 10 by 20 cm. The contrivance, kept placed so that the partition is approximately in the median interocular vertical plane, is moved back and forth until the hole is at the crossing point of the eyes. This can be assured by alternately covering one and then the other eye and noting that no movement of fixation occurs. As seen with the right eye alone, the right half of the hole appears red, the left half black, and as seen with the left eye alone, the left half appears green and the right half black. To a normal person with both eyes open, the hole sometimes appears as seen with the right eye alone, and sometimes as seen with the left eye alone, but sooner or later the right half appears red and the left green at the same time. Often rivalry between black and color is observed on one or both sides. With this contrivance, I have tested many convergent squinters, excluding those with poor vision and those in whom I was able definitely to elicit binocular fixation by other means. In almost all of the cases in which the test was employed, replacement, judging by the statements of the subject, similar to that often observed by a normal person was obtained, at least momentarily, when the hole was at the crossing point. When the hole was carried farther away, it appeared as when seen with the fixing eye alone; when it was brought nearer this was also true, or it was seen double. When in addition to esotropia there was hypertropia of considerable degree, the test failed, evidently because there was no crossing point.

While in the case of the squinter as regards the hole considered as an entire object there undoubtedly occurred incomplete replacement exactly similar to that which may occur in a person with normal vision, it is to be noted that the replacement really consisted in complete replacement of relatively large areas. In normal replacement, areas completely replaced may be as small as the smallest visual units and may be distributed in almost every conceivable way. In an area such as that

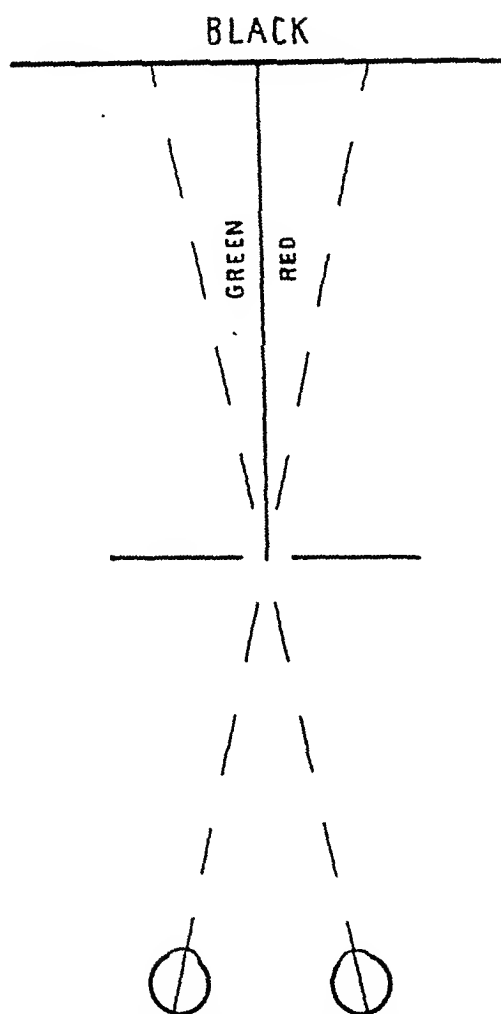


Chart 2.—Diagram of "replacement tester," with hole at the crossing point of the eyes.

concerned in the test, there may be observed by a normal person not merely sudden recurring changes of the whole area from black to red and from red to black, but in various parts of the area transitions as if the finest possible mixing of black and red in varying proportions were occurring. Judging by his statements, this sort of replacement also occurred in the squinter, but the phenomenon took place so quickly that it was doubtful that his statements in this respect could be relied on. Unfortunately, no attempts were made to elicit luster at the cross-

ing point. As already stated, other tests failed to show binocular mixture of colors at this point.

Another question that arises is whether or not in the replacement test with the hole at the crossing point binocular fixation is elicited. Obviously, to demonstrate binocular fixation it would be necessary to prove that it was maintained through some range. As a matter of fact, without loss of incomplete replacement the hole could not be moved a sufficient distance forward or backward to indicate any range of binocular fixation. Still another question is whether or not the test causes correspondence of the primary visual axes. If while the squinter was fixing the hole at the crossing point a rod was placed at a distance from the hole on the primary visual axis of the usually squinting eye, the rod did not appear in line with the hole even when removed from view of the other eye by means of a partition. When another rod was placed in the primary visual axis of the nonsquinting eye, two rods were clearly seen, with or without the partition. The rod before the nonsquinting eye appeared in line with the hole, while the other rod did not appear in line with the hole but was seen in the same position in which it appeared when the squinting eye was occluded. Hence it was evident that correspondence of the primary visual axes did not exist during the replacement test.

The fact that apparently normal replacement may occur when a suitable object is at the crossing point suggests, incidentally, that in cases of convergent strabismus the most effective way to develop binocular fixation and binocular stereopsis would be for the squinter frequently to observe a suitable object moved slowly backward and forward in the vicinity of this point.

It is, of course, a familiar fact that in certain cases of established concomitant strabismus binocular fixation occurs or can be elicited at times. In some of these cases anomalous projection has been demonstrated when the eyes were deviated. Bielschowsky ^{11b} long ago reported cases of this kind. As a matter of fact, as already stated, I have found that anomalous projection always exists in established cases of concomitant strabismus when the eyes are deviated. According to usual conceptions, there is supposed to be "normal correspondence" when there is binocular fixation and "anomalous correspondence" when the eyes are deviated. In most of these cases the strabismus is of the divergent type, owing no doubt to the fact that often in cases of divergent strabismus binocular fixation has long been utilized before the strabismus has become relatively permanent. I have found that in many of the cases of divergent strabismus binocular fixation can be elicited only for near objects, and sometimes then only when excessive accommodation is produced by means of concave lenses. Probably, however, in cases of convergent strabismus anomalous projection and binocular fixa-

tion thus coexist more often than is suspected, especially in cases in which the deviation in distant vision is so slight that the strabismus itself is overlooked or in which a slight deviation in distant vision is recognized but the occurrence of binocular fixation in near vision is overlooked. I have discovered a number of such cases which I had previously not recognized. In most of these cases the patient stated that definite convergent strabismus had existed in childhood. There are also cases in which with corrected hypermetropia the patient has binocular fixation and stereopsis for distant objects but convergent strabismus for the reading distance.

In a considerable number of the cases under consideration I have been able by means of the kinetic test¹⁹ to demonstrate excellent binocular stereopsis during binocular fixation. In some cases, however, evidently because of the unusual conditions required, binocular fixation either could not be obtained at all in the test or was lost as soon as one of the "balls" was moved. No doubt in most, if not all, of these cases binocular stereopsis existed under ordinary conditions when there was binocular fixation and could have been demonstrated if there had been employed a test which I have recently devised for the purpose, and which I shall describe in a subsequent communication.

Until lately I have accepted as a fact the usual assumption that when binocular fixation exists in these cases retinal correspondence is substituted for anomalous projection. Recently, I put this assumption to actual tests in 5 cases, especially suitable owing to the intelligence of the subjects. In 3 cases the strabismus was divergent, and in the others, convergent. To my surprise the tests showed that the assumption was incorrect, in that anomalous projection continued to exist in spite of binocular fixation and in spite of the fact that retinal images projected to the fixation point underwent normal replacement. In 2 of the cases I was even able to demonstrate the perception of binocular luster, and in 1 of these there was also perception of a binocular mixture of red and green as yellow. In each case there was unquestionably demonstrated binocular stereopsis when there was binocular fixation.

Although I have not yet proved it to be an actual fact, it is probable that in such cases peripheral retinal areas exhibit the same phenomena as the two foveas. In other words, in such cases there probably exists a surface which may be termed a replacement surface, similar to a normal horopter. If two retinal images are projected to the same place in this surface, they may undergo normal replacement. If the same two images are projected beyond this surface, they are seen separated

19. Verhoeff, F. H.: A Kinetic Test for Stereoscopic Vision, *Arch. Ophth.* 15:833 (May) 1936.

laterally in space, and each is seen without obscuration by the other. It would seem, therefore, that in cases of established concomitant strabismus, whether or not the crossing point is determined by binocular fixation, correspondence of the primary visual axes does not necessarily exist even when the object of chief attention is situated at this point, nor does correspondence of the visual axes of any object situated on the replacement surface probably exist. Moreover, it would seem in such cases that while partial replacement of one retinal image by its contraocular retinal image can occur only when the images occupy certain fixed contraocular retinal areas, it does not necessarily occur when they occupy these areas. Usually, in fact, each image is then completely seen, unobscured by and separated laterally from the other. Further discussion of the intricate questions here involved is reserved for a communication at a later date, when similar and more searching investigations in regard to it have been carried out in a large number of cases.

Whether or not in the absence of binocular fixation the factor of interocular distance contributes to the perception of depth in cases of strabismus is uncertain. In other words, it is uncertain in such cases whether or not in binocular vision retinal images not consciously perceived play any part in determining the apparent localization of their objects. In the case of the squinter the conditions are possibly somewhat analogous to those that exist in the case of animals the visual fields of which overlap and which have conjugate ocular motion but no convergence. Some of these animals, notably the cat, evidently have excellent judgment of distance. If the eyes of the squinter always maintained a fixed positional relation to each other, as they apparently do in the cat, it is evident that for every position of the eyes, that is to say, for every state of conjugate ocular motor innervation, the position in external space of each point in the binocular field could definitely be determined by the positions of its two retinal images. Just as in the case of disparate images in a normal person, one of the images need not be represented in consciousness while aiding in the perception of depth. But, as compared to the cat, an animal that has no definite foveas, a strabismic person has two disadvantages: When he fixes an object situated, as it generally is, beyond the crossing point, one of the images, since it is further from the fovea, is much more indefinitely represented in the brain than the other, and when the object is placed at different distances the positional relation of the eyes changes, owing to the persistence of the function of convergence. In the case of the cat as well as in that of the squinter, therefore, binocular criteria of depth are available. In the case of a convergent squinter, the nearer objects are to the crossing point, the more definite are the available binocular criteria of relative depth. Hence such criteria presumably

would be most effective for objects within easy reach, that is, within a range within which depth perception is most valuable. But it has never been demonstrated that a squinter when not manifesting binocular fixation ever under any conditions actually makes use of his available binocular criteria of depth. The various tests for stereopsis that I have described elsewhere, including especially the "kinetic test,"¹⁹ have failed to demonstrate binocular stereopsis in any case of strabismus during the absence of binocular fixation. Such tests, however, require the use of an instrument such as the stereoscope, and it is possible, in fact probable, that this prevents the acceptance of binocular criteria of depth when binocular fixation is absent. Bielschowsky^{11b} found exceptionally with the falling ball test that squinters gave a definitely higher percentage of correct answers when both eyes were open than when the squinting eye was occluded. But a slight increase in the percentage of correct answers does not indicate accuracy of stereopsis commensurate with the binocular criteria. Furthermore, it is not certain that the improvement in depth perception indicated by the falling ball test was due to binocular stereopsis. Several other possible explanations of the results were not excluded, especially the explanation that images within the macula of the squinting eye are localized more accurately in space than are images outside the macula of the fixing eye.

The fact, demonstrated by me in many cases, that all objects appear to be in the same positions whether seen with the fixing eye alone or with both eyes or with the not consciously perceived images excluded by screens seems to prove that the anomalous projection is substantially correct without the aid of these images. However, before the possibility can be dismissed that these images increase the precision of the projection for objects situated within easy reach of the hands, particularly in cases of convergent strabismus, more decisive tests must be employed. The fact that the brain generally makes use of all available criteria makes this possibility almost a probability. With reservations based on this possibility, it would seem that in cases of anomalous projection determinations of the apparent positions of objects are primarily made separately for each eye, by correlation of the conjugate ocular motor mechanism with retinal position and other monocular sensory criteria, and that the separate determinations are then secondarily correlated with respect to the point of view of the fixing eye.

Retinal correspondence, including its remarkable precision, is no doubt primarily dependent on the inheritance of certain sensory factors that are largely if not wholly anatomic. The fact that concomitant strabismus is so often definitely hereditary and the character of the visual phenomena associated with it suggest that it may represent a hereditary reversion to a more primitive type of sensory relation. But,

on the other hand, it is possible that anomalous projection is acquired entirely by experience and that the hereditary factors primarily have to do only with the ocular motor mechanism, particularly with that concerned in convergence, or with the correlation of the motor with the sensory mechanism. In favor of this view is the fact that anomalous projection develops in the many cases in which the strabismus is almost certainly due to excessive accommodation resulting from uncorrected hypermetropia. However this may be, it is clear that at least the accuracy of anomalous projection is determined by experience. This fact is well shown in a case recently observed by me. The patient had marked convergent strabismus with good vision in each eye at an early age and was operated on with only partial success. At the age of 41 tenotomy had been performed. The tendon had not adhered to the globe, and divergent strabismus gradually resulted. Although the patient at the age of 53 had binocular fixation for some positions, when his eyes were divergent he had anomalous projection that was substantially correct. The tenotomized tendon was then advanced to about its original position. Convergent strabismus resulted, and anomalous projection developed or was resumed, again substantially correct, entirely different from that existing when the eyes were divergent.

Satisfying explanations of the phenomena of normal and abnormal vision will remain impossible until essential details concerning the correlations of the nervous mechanisms of the brain in general, including particularly the correlations that especially have to do with visual perception and ocular motility, are available. At present, such details are almost if not entirely lacking.

SUMMARY AND CONCLUSIONS

Precise definitions of corresponding visual axes and of corresponding retinal points are given, based on a method by which such axes and points can be determined. Corresponding visual axes are defined as any two visual axes that as visualized from their respective eyes with the aid of suitable objects appear to coincide. The imaginary line in which they appear to coincide is termed a binocular visual axis. Corresponding retinal points are defined as any two points that are the retinal optical terminals of a pair of corresponding visual axes. The term "retinal correspondence" is synonymous with "normal type of binocular projection."

In most if not all cases of concomitant strabismus, when the eyes are deviated no corresponding visual axes, and hence no corresponding retinal points, can be demonstrated. Anomalous projection is therefore defined as a type of binocular projection in which there are no corresponding visual axes. Associated with it, there can be said to be quasiretinal correspondence. Hitherto it has mistakenly been regarded as unusual, and visual phenomena peculiar to it have been misinterpreted.

During binocular vision in cases of anomalous projection, the retinal image of any object seen usually reaches consciousness only from the eye from which this particular object could be the more distinctly seen in monocular vision without change in fixation. The apparent absolute positions of all images that reach consciousness from the squinting eye are determined by the monocular projection of this eye, possibly assisted by the effects of not consciously perceived images, while their apparent relative positions are judged from the point of view of the fixing eye. The squinter reacts as if, and will usually state that, all objects in the binocular field are seen from the fixing eye alone.

In cases of anomalous projection without amblyopia, two images, one on each fovea, are projected under certain conditions to the same place, the crossing point of the primary visual axes, and under other conditions to two different places separated laterally in space. When the squinter sees the two images as if in different places, he believes that he sees them simultaneously and each completely, and there is no evidence that he does not actually so see them.

The cover test, commonly used for demonstrating heterophoria, affords a simple but conclusive method for demonstrating anomalous projection in cases of strabismus in which the deviation is not unusually slight. Various other tests, including the after-image test, are briefly discussed, and it is pointed out that results obtained by their use may be misleading in certain respects.

The total amount of "suppression" within the binocular field is almost if not exactly the same in the case of the squinter as it is in the case of a normal person. In both instances it explains why in binocular vision all objects are seen singly and with about the same value they appear to have when each is seen only from the eye from which it can be the more distinctly seen. The "suppression" of the squinter, however, differs fundamentally from the "suppression" (replacement) of a normal person and hence may be termed quasireplacement. Under certain abnormal conditions there probably occurs, operating at a lower level, a still different process, to which the term subconscious visual suppression can be appropriately applied. It is more probable that the amblyopia resulting from strabismus is due to this process than to replacement, a normal process.

In almost all cases of convergent strabismus, when the visual acuity is good in each eye, replacement, apparently identical with normal incomplete replacement, can be demonstrated when a suitable object is at the crossing point of the primary visual axes. Presumably the most effective way to develop binocular fixation in a case of convergent strabismus would be for the squinter frequently to observe a suitable object moved slowly forward and backward in the vicinity of the crossing point.

Diplopia is defined as consisting of two types, disparate diplopia and corresponding diplopia.

The distinction between alternating and nonalternating strabismus is of much less importance than commonly supposed. Usually when neither eye is so amblyopic that it is incapable of central fixation, a squinter can in a few moments be taught to alternate at command.

The squinting eye, even in cases of amblyopia, plays an important part in binocular vision and provides certain advantages not possessed by normal persons. It is probable that these advantages often offset the lack of delicate binocular stereopsis.

The vision of squinters is compared to that of animals the visual fields of which overlap and which have conjugate ocular motion but no convergence.

Retinal correspondence, including its precision, is primarily dependent on hereditary sensory factors alone. Whether anomalous projection represents a hereditary reversion to a more primitive type of sensory relation or is acquired entirely by experience remains to be determined.

DISCUSSION

DR. RALPH I. LLOYD: It is not possible to explain a paper of this kind from the platform. I have never been able to understand anything of this involved nature except by sitting down and reading the paper carefully, going over some parts again and again, with illustrations appropriate to its special features constantly before me.

Dr. Verhoeff has given names and titles to various syndromes and tests, and despite the fact that many chosen may be better than those now in use, the introduction of these names without previous explanation complicates the situation. Dr. Verhoeff seems to think that there is no satisfactory definition of fusion, but one can begin by saying that this is a combination of two retinal images of two dimensions each into a single image of three dimensions. As this process takes place in the brain, one cannot study it directly as one would like to, but the demonstration by Henschen of the anatomic arrangement of the visual cortex does give some help toward a better understanding. According to this, studies of the arrangement of the cells in the visual cortex show there are three layers of nerve cells in Gennari's stripe, considered as the ultimate end organs of vision. These may be likened to a sandwich, with the bread representing a superficial and a deep layer of nerve cells, each layer being connected with one layer of the two-layered binocular field of vision. The meat placed between the other two layers is considered as the final organ of vision, wherein an impression registered on the superficial layer and another registered on the deep layer of nerve cells are combined by cells in the intermediate layer. Any process altering the worth of an impression registered on one layer has a decided effect on the resulting mental combination. The best illustration of the effect of altering the image of one eye only is the Pulfrich stereophenomenon. A pendulum is arranged to swing from side to side, with the suspension point and all other aids to localization by the patient occluded. If a smoked glass is placed before

the left eye, the pendulum seems to swing in an oval orbit, moving toward the observer and in front of its normal line of motion as it passes from right to left. On the return trip, that is, from left to right, its path is apparently behind the normal plane and just as much as it was in front in the first half of its swing. If the smoked glass is made heavier and heavier, there will come a point at which the combination of the two images is apparently no longer possible, and the pendulum again swings in the normal plane; but it will now be found that the poorer image is suppressed and that the patient is using but one eye. It is argued, and with good reason from my point of view, that a similar process takes place in cases of squint. The image of the poorer eye is no longer combinable with the image of the good eye, and the visual axis of the poorer eye is swung out of line to permit suppression of the poorer image. When one image is different from the other, as in the Pulfrich test, the image of the eye with the smoked glass before it is weaker than the other and registers a little later than the other, creating a conflict in the mental process of combining these two images of two dimensions each into a single image of three dimensions. As the resulting image must be projected to a place common to each of the two visual axes, the binocular image of the pendulum appears to move nearer to the observer when the darker image belongs to the left eye and the pendulum is swinging to the left. This point common to both visual axes is nearer to the observer than the pendulum as it swings from right to left, but is behind the path of the pendulum when it is on the return trip, from left to right.

Dr. Verhoeff's observations of the effect of an image placed along the visual axis of the squinting eye while the good eye is fixing and the variations of this conform to what is to be expected under the conditions. That suppression of the image of the poorer eye affects only the macula has long been accepted, and the last function the macula loses, irrespective of the position of its visual axis and irrespective of the habit of suppression or lowered visual acuity, is the imperative impulse to fusion of images, impressed on the macula. If the poorer eye squints, as it must do to eliminate the unpleasant subconscious conflict following the effort to combine two unlike images, an object placed so that its image will fall on the squinting macula in the new position will instantly awaken efforts to get the two images to fuse. As the disparity of the macular functions is often too great to allow this consummation, after more or less diplopia a readjustment of the position of the squinting eye allows the original state of suppression of the macular image of the poorer eye to recur, and a comfortable use of the eyes is possible.

DR. LEGRAND H. HARDY: Not having read Dr. Verhoeff's paper, my knowledge of what he believes is limited to what he has said here. I failed to comprehend the significance or relevance of many of his statements, but from the material I did gather I should be forced to draw a set of conclusions differing from his. On the other hand, he has made several statements which I believe not only to be true but to be significant and not widely known. The facility with which a monocular squinter can be taught to alternate is an example. The significant differences in the meaning of words, such as "straight" and "crooked," and the different state of kinesthetic knowledge in the

squinter are less well known examples. The close relation of alternating squint to the monocular type has been accepted only in the past few years.

Dr. Verhoeff has so strongly stressed the superiority and advantage of the strabismic state that one could easily believe that he considers it to be a desideratum.

I draw the following conclusions from his discussion: that he performed the experiments he has outlined here with a few intellectually superior and cooperative patients; that he has not done much clinical orthoptics; that he has not used the synoptophore (or one of the other major amblyoscopes) much as a therapeutic instrument, and that he is not justified on the basis of the material presented in categorically condemning orthoptics as a part of ophthalmologic practice.

He is justifiably derisive toward much that has been published on orthoptics. Nevertheless, sufficient reliable work has been done by trustworthy observers to invalidate a blanket pronouncement, and I should consider it a disservice to ophthalmology should Dr. Verhoeff seek to dissuade any intelligent and earnest ophthalmologist from making attempts to aid his heterophoric and heterotropic patients by means of orthoptic efforts.

DR. JOSEPH I. PASCAL: I want to ask Dr. Verhoeff if he ever found actual fusion of the images at the crossing point. That is, if the images are superposable and fusible, are they not fused at that point? In my experience that has happened. Another point I want to raise is whether this anomalous projection which Dr. Verhoeff has shown in the deviating eye as being projected to the left, according to the direction of the fixing eye, is not similar to what is present normally. It may be a midline, a bivisual line as Duane calls it, or it may be the visual axis of the dominant eye which serves as the base line for the projection of images in the visual field. In this case, the fixing eye being extremely dominant, the image that falls on the other eye is projected according to the normal manner, with the visual axis of the dominant eye as the base line of projection.

DR. F. H. VERHOEFF: At the crossing point I have demonstrated replacement similar to that which occurs in the normal person. No doubt Dr. Pascal would call this fusion. In cases of anomalous projection there are no binocular visual axes; hence the fixing eye is not a dominant eye in the same way that one eye may be dominant in a normal person. Moreover, since objects are projected with reference to the point of view of the fixing eye, in cases of alternating squint it is not always the same eye that could be regarded as dominant in any sense.

DR. JOSEPH I. PASCAL: Normally, when one looks at a point, that is, fixes an object, all the other objects in space are projected with one line acting as a single reference line.

DR. F. H. VERHOEFF: In the case of persons with normal binocular vision, all objects seen by the right eye on a visual axis of the right eye and all objects seen by the left eye on the corresponding visual axis are projected during binocular vision along a single axis, a binocular axis. In the case of squinters with anomalous projection, this is not true, for there are no corresponding axes.

DR. JOSEPH I. PASCAL: They have the monocular axis.

DR. F. H. VERHOEFF: (Diagrams drawn on the blackboard were used by Dr. Verhoeff to explain various points considered in his paper.) In regard to Dr. Lloyd's remarks, I may say that I am familiar with the work of Henschen to which he referred. Many years ago I brought forward a theory of normal binocular vision which accords with Henschen's anatomic observations, but I have not yet been able to explain anomalous projection from an anatomic point of view. I do not agree with Dr. Lloyd that the Pulfrich phenomenon is of importance in explaining binocular stereopsis. The Pulfrich phenomenon is simply due to delayed perception of one of the retinal images of the pendulum, so that there is disparateness of images in the brain. The phenomenon throws no more light on how disparateness produces the effect of depth than do ordinary stereoscopic diagrams. Dr. Pascal asks about fusion at the crossing point. I should like him to define what he means by fusion.

DR. JOSEPH I. PASCAL: I mean superposition of the images; if they are fusible, they fuse. Take an F and an L, and see if they fuse as an E.

DR. F. H. VERHOEFF: If Dr. Pascal calls that fusion, then I am sure that he would say that in cases of anomalous projection my replacement tester shows perfect fusion at the crossing point. I have been able to demonstrate the perception of binocular luster here only when the crossing point was determined by binocular fixation. No distinction is commonly made between binocular fixation and fusion. Travers in his recent monograph does not once use the term binocular fixation, although it is evident that he often means this when he speaks of fusion. For the seeing of two corresponding images as one image I have suggested the term unification. For this phenomenon and for replacement in general I have given an explanation in my paper on "A New Theory of Binocular Vision."¹⁰

Dr. Hardy spoke about the horopter. In order to have a horopter there must be corresponding retinal points. Patients with anomalous projection do not have a horopter because they have no retinal correspondence.

CANCER OF THE EYELIDS

I. BASAL CELL AND MIXED BASAL CELL AND SQUAMOUS CELL EPITHELIOMA

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Recently I¹ studied the records of 464 cases of cutaneous cancer which arose from the eyelids, from the conjunctiva or from both. Of the carcinomas in this series, 230 were examined and graded histologically; others, for one or another reason, were not. About 60 per cent of the 230 growths, actually 139 of them, were basal cell epitheliomas, and approximately 14 per cent, or 32 of them, were mixed basal cell and squamous cell epitheliomas. This paper is primarily concerned with these two groups, composed respectively of 139 and of 32 tumors.

ETIOLOGY

Whereas the majority of the pure basal cell epitheliomas occurred in persons in the sixth decade of life, the majority of the mixed cell epitheliomas occurred in those in the fifth decade. Men were affected in 61.1 per cent of the cases of basal cell epithelioma and in 65.6 per cent of the cases of mixed basal cell and squamous cell epithelioma.

The etiology of all types of epithelial tumors is related to some extent to trauma and to chronic irritation. In this series, 29.5 per cent of the basal cell epitheliomas were said to be definitely related to these factors. They included mechanical injury from eyeglasses, chronic blepharitis, injury due to squeezing of blackheads or of pimples and the presence of warts, cysts or chalazions which did not heal properly. Of the mixed cell epitheliomas, 31.2 per cent were associated with a history of chronic irritation of some type.

TREATMENT

In 19 of this group of 139 cases of basal cell epithelioma, the most radical type of treatment was resorted to, that is, exenteration of the contents of the orbit. In 9 other cases it was necessary to enucleate

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1. Birge, H. L.: Epithelioma of Eyelids and Conjunctiva, unpublished thesis.

the globe. In many of these cases, in addition, varying doses of radium were given. Treatment in the remainder of the cases consisted of excision, including diathermy and cauterization, or of a combination of operation and irradiation.² The patients who received only irradiation are not considered here but will be dealt with as a separate group.

In this series, exenteration was performed on 20.7 per cent of the patients with mixed cell epithelioma and on only 14.9 per cent of those with pure basal cell epithelioma. This difference in treatment may be in favor of the prognosis of the mixed type of tumor, the more radical method causing a lower gross mortality. If such is the case, the lower malignancy of the mixed basal cell and squamous cell epithelioma is not as great as it appears.

TABLE 1.—*Results of Follow-Up Study of One Hundred and Twenty-Seven Patients with Basal Cell Epithelioma*

Situation of Growth	Total No. of Pa-tients	No. of Pa-tients Traced	Exenteration		Enucleation		Blind in Affected Eye		Died of Carcinoma	
			No. of Pa-tients	Per-cent-age	No. of Pa-tients	Per-cent-age	No. of Pa-tients	Per-cent-age	No. of Pa-tients	Per-cent-age
Lower lid.....	76	69	10	14.5	5	7.2	18	26.0	7	10.1
Upper lid.....	14	10	2	20.0	0	0	2	20.0	2	20.0
Inner canthus....	37	36	6	16.6	3	8.3	11	30.6	5	13.9
Outer canthus....	12	12	1	8.3	1	8.3	2	16.6	0	0
Entire group....	139	127	19	14.9	9	7.0	33	26.0	14	11.0

RESULTS

Of the 139 patients with basal cell epithelioma, contact was maintained with 127 until 1936. In some cases this represented a follow-up study of more than fifteen years' duration. Eighty-two of the patients were living, 31 had died of causes other than epithelioma and 14 had died from the effects of the epithelioma. This represents a gross mortality of 11 per cent (table 1).

Why should a comparatively benign epithelial tumor situated where it is constantly open to view by the patient and by all who associate with him have a mortality of 11 per cent over a period of fifteen years? I do not believe the fault lies largely with the medical profession. Most of the fatalities are owing to neglect on the part of the patient. Pain is not an early symptom of these lesions. Only 20 per cent of this entire series of 464 patients sought adequate treatment during the first year.

Blindness occurred in 25.9 per cent of the cases of basal cell epithelioma of the eyelids. Basal cell epithelioma did not seem to be as

2. Benedict, W. L., and Knight-Asbury, Mary: Treatment of Malignant Lesions of the Eyelids, New York State J. Med. 29:675-677 (June 1) 1929.

malignant under the forms of treatment used in this series of cases as was reported in general by Broders and MacCarty³ in 1916. At that time the general mortality from basal cell epithelioma was 35 per cent.

Basal cell epitheliomas situated in different places on the eyelids were attended by different degrees of mortality. The upper eyelid and the area of skin near the inner canthus were the situations associated with the greatest mortality. Lesions near the inner canthus and those of the lower lid were associated most frequently with blindness. Mixed basal cell and squamous cell epithelioma caused death only when situated near the inner canthus. The incidence of blindness was also highest when the mixed cell type of tumor occurred near the inner canthi.

The mixed cell type of epithelioma was attended by a gross mortality of only 6.8 per cent (table 2). It presented nearly as great a hazard to eyesight, however, since in nearly 25 per cent of the 32 cases blindness in the affected eye had occurred by 1936.

TABLE 2.—*Results of Follow-Up Study of Twenty-Nine Patients with Basal Cell and Squamous Cell Epithelioma*

Situation of Growth	Total No. of Patients	No. of Patients Traced	Exenteration		Enucleation		Blind in Affected Eye		Died of Carcinoma	
			No. of Patients	Percentage	No. of Patients	Percentage	No. of Patients	Percentage	No. of Patients	Percentage
Lower lid.....	14	13	2	15.4	0	0	2	15.4	0	0
Upper lid.....	5	4	1	25.0	0	0	1	25.0	0	0
Inner canthus.....	9	8	1	12.5	0	0	3	37.5	2	25.0
Outer canthus....	4	4	2	50.0	0	0	1	25.0	0	0
Entire series....	32	29	6	20.7	0	0	7	24.1	2	6.8

Basal cell epithelioma is only one type of epithelioma found near the eye, and for a better conception of the importance of this lesion a comparison of its course should be made with that of other types of epithelioma (table 3).

Comparison of the percentages of patients with the various types of epithelioma living at the end of three years shows that there is a difference of only 7 or 8 per cent in the behavior of all types of epithelioma early in their course. As time passes, however, certain types of epithelioma definitely become more malignant. This variability in malignancy according to pathologic grading will be shown more emphatically when squamous cell epithelioma is considered. In table 3 it is seen that basal cell epithelioma is more benign than is squamous cell epithelioma. This is only true in part. The basal cell tumor is more benign than is the entire variety of squamous cell tumors, but when basal cell lesions are compared with the individual grades of squamous

3. Broders, A. C., and MacCarty, W. C.: Melano-Epithelioma, Surg., Gynec. & Obst. **23**:28-32 (July) 1916.

cell lesions, basal cell epithelioma is found to be more malignant than are certain grades of squamous cell epithelioma. This is well shown in figure 1.

COMMENT

Cutaneous cancer comprises approximately 12 per cent of all epitheliomas.⁴ Cancer involving the eyelid comprises from 3 to 5 per cent of all epitheliomas.⁵ The term "cutaneous cancer" is not limited in meaning to any one type of tumor, and consequently definite help in prognosis is not derived from use of this loose term in diagnosis. On the basis of a pathologic diagnosis a more definite prognosis can be made.

Epitheliomas near the eyelid and conjunctiva show definite variation in ability to blind and to cause death according to their pathologic types. It is important for the clinician to know whether an epithelioma is of

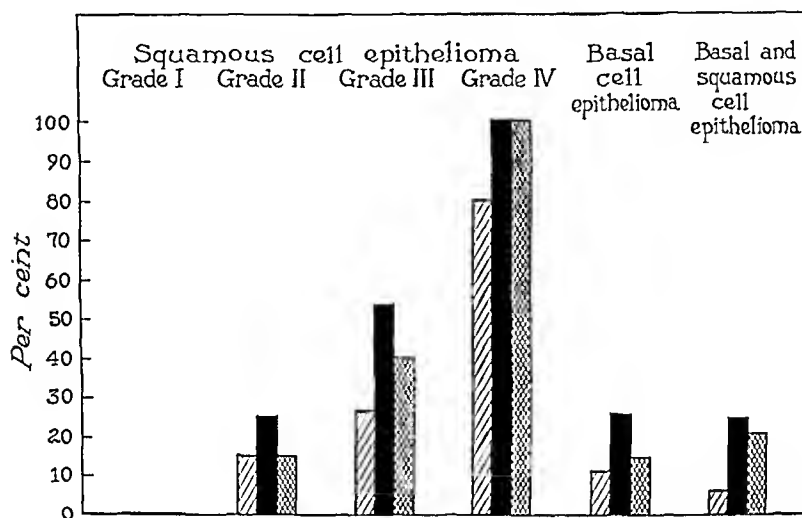


Fig. 1.—Mortality and blindness produced by various grades of epithelioma found about the eye. The area of diagonal lines indicates the number of patients who died of cancer of the eye; the solid area, those who became blind as a result of lesions of the eye, and the area of crossed lines, those who underwent exenteration.

the basal cell type, of the squamous cell type or of a mixture of the two types. The presence of both basal cells and squamous cells in a lesion seems to be important, as viewed in the light of this series, because of the lower mortality that occurred among the patients who had mixed basal cell and squamous cell epitheliomas. The lower mortality attending this type of tumor may be explained on the basis of a greater tendency to differentiation of the individual tumor cells.

4. Broders, A. C.: Squamous-Cell Epithelioma of the Skin, *Ann. Surg.* **73**: 141-160 (Feb.) 1921.

5. Geschickter, C. F., and Koehler, H. P.: Ectodermal Tumors of the Skin, *Am. J. Cancer* **23**:804-836 (April) 1935.

The prognosis varies not only with the pathologic type but with other factors, including age, size of the lesion, type of treatment received previously and occupation.⁶ Especially important in dealing with the early lesion is its situation on the eyelid. The chief danger associated with any tumor of the eyelid lies not so much in the occurrence of metastasis as in extension of the process into the orbit and into the cranial cavity.

Basal cell epithelioma is the most frequent type of tumor of the eyelid, as it is of the skin in general. Nevertheless, the basal cell epithelioma that involves the eyelid is not a common tumor from the standpoint of the general surgeon or the pathologist. In fact, it does not occur frequently even among tumors of the eyelid. O'Brien and Braley found only 15 carcinomas among 100 consecutive tumors of the eyelids.⁷

The importance of basal cell epithelioma is mistakenly minimized by the conception generally held that basal cell lesions are associated with but a slightly more serious outcome than are benign tumors. To the ophthalmologists, the basal cell lesion of the eyelid becomes important in proportion to its ability to blind or to kill. Basal cell tumors are quite likely to cause blindness of the affected eye, in spite of the use of every known method of treatment or of a combination of treatments. Basal cell epithelioma is, therefore, an important type of tumor, and the ophthalmologist should be familiar with it.

In this series,¹ basal cell epithelioma did not arise primarily from the conjunctiva or from the cornea, as did squamous cell epithelioma. Frequently, however, it involved the conjunctiva and the cornea secondarily.

It has been said that the most satisfactory method of treating basal cell epithelioma is by irradiation. This is not true in every case, although irradiation proved effective in the cases in which it was used in the whole series of 464. The main objection is that when a specimen is not taken for biopsy the pathologic type of the lesion being treated is not known. The danger of irradiation, cataract or other complication damaging sight is small when the dosage is properly given.

In order to save time, which is important in dealing with malignant growths of high grade, epitheliomas should be examined histologically before one decides on a definite course of treatment. If the lesions are small, as they often are about the eyelids, complete excision is preferable to biopsy. If irradiation is used without previous histologic examination, a certain percentage of patients who have lesions which

6. Lane, Laura A.: Symposium on Cancer: An Occupational Study of Cancer of the Eye and Adnexa, Surg., Gynec. & Obst. **64**:458-464 (Feb.) 1937.

7. O'Brien, C. S., and Braley, A. E.: Common Tumors of the Eyelids, J. A. M. A. **107**:933-938 (Sept. 19) 1936.

are radioresistant or of a high grade of malignancy will suffer from delay of surgical treatment. If an epithelioma of the eyelid has extended into the orbit, the chances of cure are appreciably reduced.

REPORT OF CASES

CASE 1.—A woman aged 64 had a growth on the right lower eyelid which had existed for nine months (fig. 2*a*). It was excised, and a plastic wing flap operation was performed. The pathologic diagnosis was basal cell epithelioma. One year later a lesion recurred. This was excised, but the pathologic examination disclosed that only inflammatory tissue was present.



Fig. 2.—Basal cell epithelioma: *a*, early lesion; *b*, and *c*, recurrent lesions, and *d*, neglected lesion.

CASE 2.—A man aged 64 noted gradual development of a tumor near the outer canthus of the right eyelids four years before he came to the clinic. Excision had been performed and a skin graft employed after the tumor had been present for two years. The tumor recurred (fig. 2*b*) and was treated five times with roentgen rays in the city where the patient resided. Treatment by electric needle was given just before the patient came to the clinic. Vision in the right eye was 6/20 and in the left eye 6/30. The epithelioma was excised, and a graft from the thigh was inserted. Radium, 1,037 milligram hours, was applied; the eye was protected with a 2 mm. lead shield. The pathologic diagnosis was basal cell epithelioma.

CASE 3.—A man aged 68 years had noted lumps near the outer canthus of the eyelids for three years. They grew and disappeared but recurred (fig. 2 *c*). A diagnosis of basal cell epithelioma was made, and the patient was advised to have radiation therapy.

CASE 4.—A man aged 62 had a growth on the left lower eyelid for ten months. It began as a small pimple, varied in size and then grew again and became flaky. The lesion had been treated with castor oil, sodium bicarbonate and grease (fig. 2 *d*). There were enlarged lymph nodes in front of the left ear and in the submaxillary region (inflammatory). This lesion proved to be a basal cell epithelioma. Also, there were present two other large basal cell epitheliomas; one was situated on the chin, and the other was situated over the left mastoid prominence. Radium therapy was advised because of the extent and multiplicity of the lesions.

CASE 5.—A woman aged 55 injured her left upper eyelid with the rider of her eyeglasses (fig. 3 *a*), after which a mass developed, which measured 7 by 3 mm.



Fig. 3.—Mixed basal cell and squamous cell epithelioma: *a*, early lesion, and *b*, neglected lesion.

It was excised with the diathermic knife, and the pathologic diagnosis was mixed basal cell and squamous cell epithelioma.

CASE 6.—A man aged 61 had a tumor on the left side of the nose where eyeglasses had touched it. The tumor had been present for ten years and had been treated with radium occasionally. One year before he came to the clinic he discontinued radium therapy and took up faith healing. At the time of examination at the clinic the growth measured 4.5 by 4.5 by 2.5 cm. It was red and firm but was not broken down (fig. 3 *b*). The pathologic diagnosis was basal cell and squamous cell epithelioma, grade 3. Exenteration of the contents of the orbit was performed, and he was given 14,000 milligram hours of radium.

SUMMARY AND CONCLUSIONS

In a group of basal cell and of mixed basal cell and squamous cell epitheliomas, the mortality rate of the basal cell epitheliomas of the eyelids was 11 per cent; that of mixed basal cell and squamous cell epitheliomas was 6.8 per cent.

Of the patients who had basal cell epithelioma of the eyelid, 46.1 per cent lived fifteen years or more after they received treatment. Of the patients who had mixed basal cell and squamous cell epithelioma, 75 per cent lived fifteen years or longer after treatment was received.

The basal cell lesion was more malignant than was either the mixed basal cell and squamous cell epithelioma or the lower grades of pure squamous cell epithelioma.

Blindness resulted from basal cell epithelioma in 25.9 per cent of the affected eyes in 127 cases in which a follow-up study was made. Blindness was equally frequent in the group of cases of mixed cell epithelioma.

The mortality and blindness resulting from basal cell epithelioma could be reduced considerably if patients would report earlier for treatment and if they were observed more regularly after treatment had been given, until they were cured. Only 20 per cent of the patients in the entire series of 464 sought adequate treatment in the course of the first year.

Treatment of tumors of the eyelids should be governed by pathologic diagnosis. Basal cell epithelioma was only one type of malignant tumor found on the eyelid. Each variety of tumor differed from others in its ability to cause blindness and death. With utilization of the knowledge concerning the relative malignancy of the different tumors of the eyelid, further refinements of treatment may be accomplished.

SUPERFICIAL PUNCTATE KERATITIS

ITS TREATMENT WITH IODINE SOLUTIONS

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AND

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The term superficial punctate keratitis may be considered a general morphologic designation for multiple, small, discrete lesions of the cornea which affect only the epithelial and the immediate subepithelial tissues. Excluding those cases in which the condition is obviously due to various chemical irritants, there remain two clinical variants generally seen in the United States. Graves¹ has described these as the subepithelial and the epithelial type. In the former, exemplified by the classic superficial punctate keratitis of Fuchs, the lesions are relatively few in number and centrally located on the cornea, with perhaps some "metastatic" lesions toward the corneal margins. These lesions are usually circular and slightly raised, with crenated edges, and are visible macroscopically. They cause some disturbance of Bowman's membrane or of the underlying stroma. The epithelial type consists of multiple tiny erosions occurring all over the cornea, especially at the margins. Only the epithelium is affected, the underlying tissues remaining intact. There seems to be no general accord on the correlation of these two morphologic pictures with the etiology or the clinical course of the disease. Authors generally agree, however, that the condition is variable, that it may last indefinitely and that it may recur after apparent recovery has taken place. This uncertain course is especially true of the epithelial type.

TREATMENT AND RESULTS

In regard to treatment, most authors voice pessimism on the response of superficial punctate keratitis to various forms of therapy and on the ability of treatment to prevent relapses. Doggart² stated that a large number of different remedies have been used but that none

Read before the Section on Ophthalmology, College of Physicians of Philadelphia, Oct. 21, 1937.

1. Graves, Basil: Diseases of the Cornea, in Berens, C.: *The Eye and Its Diseases*, Philadelphia, W. B. Saunders Company, 1936, pp. 511-513.

2. Doggart, J. H.: Superficial Punctate Keratitis, *Brit. J. Ophth.* **17**:65 (Feb.) 1933.

has been found which will hasten the absorption of the corneal opacities, and that the natural course of the disease, lasting months or years, takes place regardless of the form of therapy. Chambers³ advocated the use of physiologic solution of sodium chloride and considered it equal to any other form of treatment. Lloyd⁴ stated that no treatment superior to the customary protection and the use of a local antiseptic has been discovered.

The question as to whether superficial punctate keratitis is really allied to herpetic keratitis is, of course, open to grave question, but the success of iodine therapy in conditions known to be of a herpetic nature prompted us to try equivalent agents in the treatment of superficial punctate keratitis, some forms of which are considered by many clinicians to be herpetic. Iodine has been used by others in the treatment of superficial punctate keratitis. Gifford⁵ advocated the cauterization of the individual lesions with tincture of iodine. This method is somewhat inconvenient, especially with the epithelial type, in which the multiplicity and small size of the erosions make the procedure all but impossible. Fradkine⁶ used an iodine preparation intravenously in three cases with success.

In our private practice during the past eighteen months we have been using preparations containing iodine in the treatment of superficial punctate keratitis. Our routine is to prescribe for use at home by the patient a 1 per cent solution of potassium iodide, containing 1 or 2 minims (0.06 or 0.12 cc.) of compound solution of iodine U. S. P. to the ounce (29.57 cc.). This is instilled into both eyes (even if the condition is unilateral) three times a day and is continued long after recovery, to prevent recurrences.

For treatment in the office, Pregl solution⁷ is employed in the form of conjunctival packs. This solution has been found by Cowan and Jordan⁸ to be valuable in the treatment of other corneal diseases, par-

3. Chambers, E. R.: *Keratitis Punctata Superficialis*, *Brit. M. J.* **1**:750-751 (May 2) 1931.

4. Lloyd, R. I.: *Herpes and Allied Conditions*, *Tr. Am. Acad. Ophth.* **35**:278, 1930.

5. Gifford, H.: *Ocular Therapeutics*, ed. 2, Philadelphia, Lea & Febiger, 1937, p. 202.

6. Fradkine, M. J.: *Three Cases of Superficial Punctate Keratitis Subepithelialis*, *Bull. et mém. Soc. franç. d'opht.* **45**:135, 1932.

7. Pregl's solution (concentrated) is a complex aqueous solution containing 3 per cent of available iodine in the form of hypoiodite and hypoiodate ions and some free iodine. Most of this is liberated as nascent iodine in the presence of weak acids. It is relatively nonirritating to living tissue.

8. Cowan, A., and Jordan, J. S.: *Pregl's Solution in the Treatment of Ocular Conditions*, *Pennsylvania M. J.* **38**:704 (June) 1935.

ticularly when corneal infiltration is present. The technic of application is as follows: A small loose pledget of absorbent cotton is soaked with 0.5 cc. of the fresh solution from an ampule. The lower lid, after anesthetization with butyn, is pulled away from the eyeball while the patient looks up. The pledget, held by a small forceps, is inserted into the lower cul-de-sac, and the patient is instructed to close the eye. The pack is allowed to remain for ten minutes. This treatment is repeated at intervals up to four days, when possible, until the lesions no longer stain. Whether Pregl solution employed in this manner has any greater therapeutic virtue than other iodine solutions, we have not determined. However, in the procedure outlined it causes no discomfort other than a mild burning sensation while the pack is in place. After the pack is removed, considerable conjunctival injection may be noticed, but this soon disappears.

In most of the patients we have treated in this manner we have noted a quick resolution of the lesions and freedom from, or delayed, recurrence. In all of the cases cited, whether the condition was of the type described by Fuchs or of the epithelial type, it was severe, with marked symptoms, pericorneal injection, decreased sensitivity of the cornea and gross corneal involvement, with multiple staining lesions. None of those cases, so frequently seen, in which there are a few staining points on the cornea and minor symptoms is included in the present series. No patient was considered cured until the lesions had entirely disappeared, whether symptoms were present or not.

In only two of our series of twelve cases was the morphologic picture considered to be that described by Fuchs. The staining with fluorescein in these was light and rather diffuse. In one, the lesions disappeared in two weeks, the treatment consisting of one Pregl pack and instillations of the potassium iodide solution. No recurrence had taken place at the end of sixteen months. The patient had been treated unsuccessfully with phenacaine and atropine and had worn a bandage for one month. In the other case, the condition cleared up entirely in two months, with very irregular treatment, including two Pregl packs and intermittent use of drops of potassium iodide. The patient stated that he suffered a mild recurrence after eight months, which subsided quickly under self-medication. We did not see the eye at this time.

In the remaining ten cases, examples of the epithelial type, the morphologic appearance varied from rather granular lesions, visible macroscopically and situated in the center and periphery of the cornea, to multiple tiny spots, invisible even under the slit lamp unless stained. Generally speaking, the condition had been present for long periods, and some of the patients had been unsuccessfully treated by other methods.

In four cases the condition cleared up entirely within four days, the treatment consisting of one Pregl pack and drops of potassium iodide. The disease had been present for periods varying from two weeks to four years. In four other cases recovery occurred in two weeks. Three Pregl packs and drops of potassium iodide were used in each, and the last attack had been of several months' duration. Recurrence had not taken place in any of these cases up to an average of five months.

One patient, subject to continual irritation with aggravation of symptoms every other month, recovered in one month, and was free from symptoms for about thirteen months, after which an acute recurrence took place. Drops of potassium iodide only were used by this patient for two weeks. One other patient experienced subjective comfort after the use of one Pregl pack, but a few staining lesions were present after one month of treatment, consisting of five packs and the continuous use of drops of potassium iodide. Probably this patient will suffer a recurrence.

Generally, therefore, superficial keratitis seemed to respond well to treatment with iodine. It is our impression that best results were obtained when the disease was not of too long standing. Our most difficult cases seemed to be those in which the lesions were very small and numerous. Recurrence or exacerbations occur if treatment is stopped before all staining lesions have disappeared. In a few cases in which the symptoms were severe, mydriatics were used. No bandage was applied. In some instances, in which a residual conjunctivitis remained, the lids were touched with 1 per cent solution of silver nitrate with considerable benefit. No foci of infection were removed.

In conclusion we should like to state that we realize fully the purely empiric nature of this therapy. Results have been judged without rigid control, and all of our patients have not been followed for long periods. Nevertheless, the results we have obtained so far, in a previously baffling condition, prompt us to offer a harmless procedure in the hope that it will prove equally successful in other hands.

DISCUSSION

DR. WILLIAM ZENTMAYER: I have been using for the treatment of this condition an iodine preparation composed of a 6 per cent solution of iodine in a petrolatum base. Recently I used this preparation on a patient who had a herpetic eruption on the face (not herpes zoster), with a denudation of the cornea about 7 mm. in diameter, and after treatment for two days this area was reduced to about 2 mm. The use of this preparation is not at all painful, and treatment can be repeated daily. I do not believe that there is any better therapy for scleritis than massage with this preparation of iodine.

DR. GEORGE J. DUBLIN: I should like to report a case in which I used the treatment advocated here. A patient with herpetic ulcer had

been under the usual method of treatment for approximately eleven months without improvement. I tried subconjunctival injections of Pregl's solution, but without success. In desperation I had Dr. Alfred Cowan see the patient. He suggested trying the instillation of potassium iodide and the use of Pregl's solution by means of a pack. The potassium iodide was used in 1 per cent strength and instilled into the cul-de-sac three times a day. The pack was used every other day for six treatments. At no time did the cornea fail to show some stained areas prior to the new treatment. After the six treatments there were no stained areas for three successive visits, which covered a period of two weeks. The condition of the eye improved, and the patient was discharged as cured. I attribute the cure to this form of treatment.

AVERTIN ANESTHESIA FOR OPHTHALMIC OPERATIONS

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There is no doubt that a local anesthetic is sufficient for the great majority of operations on the eye. Properly used it is highly efficient. However, there are certain patients for whom general anesthesia is not only better but definitely indicated. Very young children cannot be controlled without the use of a general anesthetic. Nervous, apprehensive patients, who in their anxiety to help often ruin a perfectly executed operation for cataract or some other delicate intraocular manipulation, should be given a general anesthetic. Operations on congested, painful globes, such as those from acute glaucoma, chronic congestive glaucoma and secondary glaucoma in acutely inflamed eyes, evisceration of acutely inflamed eyes and restoration of a socket are more easily performed with general anesthesia no matter how well a local anesthetic may be administered. Extensive orbital operations are not comfortably performed with local anesthesia, and in certain cases removal of the lacrimal sac is far from painless when a local anesthetic is used. Certainly no ophthalmic surgeon will deny that some of his patients must have a general anesthetic. Both Wilmer¹ and Davis,² in the United States, and Morgan and Lees,³ in England, were enthusiastic about the use of avertin.

Avertin was originally described by the chemists Willstaetter and Duisberg⁴ in 1923 and has been used on the Continent since 1927, since its introduction into therapeutics by the pharmacologist Eicholtz, of Freiberg. Wessley⁵ first described its use for operations on the eye in 1929. It is a crystalline white substance which is soluble in water at 40 C. up to a 3.5 per cent solution. It is a tribromomethyl alcohol and is called tribromethanol in the literature of distributors in the United States. A 2.5 per cent solution is freshly prepared at body tempera-

1. Wilmer, W. H.: Avertin as an Anesthetic in Ophthalmic Surgery, *Tr. Am. Ophth. Soc.* **28**:42-53, 1930.

2. Davis, F. A.: Tribromethanol (Tribromomethyl-Alcohol, Avertin) as an Anesthetic in Eye Surgery, *Tr. Am. Ophth. Soc.* **29**:47-74, 1931.

3. Morgan, O. G., and Lees, J. M.: Rectal Narcosis in Ophthalmic Surgery, *Brit. J. Ophth.* **14**:577-582 (Nov.) 1930.

4. Willstaetter, R., and Duisberg, W.: Zur Kenntnis des Trichlor-und-Tribrom-äthylalkohols, *Ber. d. deutsch. chem. Gesellsch.* **56**:2283-2286, 1923.

5. Wessley, K.: Die Bedeutung der Avertin-Narkose für die Augenheilkunde, *Arch. f. Augenh.* **100**:556, 1929.

ture and is never heated to above 40 or 45 C. The solution is neutral to congo red, but when heated to the point of hydrolysis it will turn congo red blue. Accordingly, before the avertin solution is used, it should be tested with congo red to see that it definitely turns orange-red in color. A dose of from 0.08 to 0.1 Gm. is given per kilogram of body weight. For obese, cachectic or debilitated patients the dose is slightly less, and for children and for robust adults between 20 and 35 years of age it is slightly higher. Women are slightly more sensitive to avertin than men. For animals the lethal dose is 1.75 times the dose necessary to produce complete anesthesia. Most of the avertin is eliminated through the urine in six hours, but traces may be found even two days later.

The patient is admitted to the hospital preferably the night before the operation, but this is not essential. A mild hypnotic, such as allylisopropylbarbituric acid with aminopyrine, phenobarbital or sodium amytal, is administered that evening. The next morning an enema is given. Two hours before the operation 1 grain (0.06 Gm.) of codeine sulfate and 3 grains (0.19 Gm.) of sodium amytal are given, or else one hour before the operation 1/6 grain (0.01 Gm.) of morphine sulfate and 1/150 grain (0.0004 Gm.) of atropine sulfate are given hypodermically. Some anesthetists, however, are strongly opposed to using morphine at all. One-half hour before the operation avertin is given by rectum. When the patient is on the operating table the usual local anesthetics are instilled into the eye the same as if local anesthesia were to be used for the operation; this includes the injection of procaine hydrochloride for control of the lids during cataract extraction, but retrobulbar injection of procaine hydrochloride is not necessary in any case. If this local reenforcement is carried out, reenforcement with gas or ether will seldom be needed, and if it is necessary the amount will be almost negligible.

Avertin has many advantages over ether. It is administered in the patient's room, and the patient is wheeled into the operating room under the influence of the anesthetic. The effect is that of a normal sleep, so that there is no stage of excitement and the patient gradually loses consciousness in from two to fifteen minutes. Surgical anesthesia is obtained in thirty minutes; it lasts for two hours and is followed by sleep and analgesia for four hours. Amnesia is complete, and the patient has no recollection of receiving the anesthetic or of the operation. This is especially advantageous with children. The patient awakens from the sleep refreshed.

There are no cardiac or pulmonary complications to be feared. There is seldom any vomiting, and if it does occur it is slight; if morphine is not used, the incidence of vomiting is negligible. Moderate excitement is rarely seen after the period of anesthesia, but in cases in which

it does occur it may be due to alcoholism. There is no apparatus near the nose and throat, as is necessary when ether is given; so there is no fear of contamination from that source. It is remarkable that when avertin is used bleeding is diminished and is definitely less than when a local anesthetic alone is used. Certainly there is much less bleeding than when ether is used. The blood pressure is moderately lowered by avertin, and the subsequent rise is never higher than to the level present before the operation. Intraocular tension is moderately decreased, and in cases of glaucoma this is a definite advantage. During cataract extraction the cornea often becomes concave after the section is made and this gives the surgeon a feeling of security.

There are few contraindications to the use of avertin. It should not be used for patients with hepatic or renal disease. It is excreted through the kidneys, and it is possible that diseased kidneys may be injured. Of course, patients with colitis or disease of the rectum should not be given avertin. Respiratory complications are rarely seen, and in cases in which they do occur inhalations of carbon dioxide, the intravenous injection of dextrose, injections of camphor and caffeine, a cleansing enema or the use of epinephrine hydrochloride will be of benefit. The death rate has been reported as 1 in 10,000.

According to Goldschmidt and Harvey,⁶ their "studies indicate that failures and accidents may be justly ascribed to unskilled application of the anesthetic and that by proper indication, proper dosage and proper method of administration of tribromethanol these may be easily avoided and furthermore, that the introduction of this drug as a basal anesthetic marks a new era in modern anesthesia."

At the Mount Sinai Hospital and the Manhattan Eye, Ear and Throat Hospital this anesthetic has been found to be extremely useful and safe for ocular operations and is recommended highly to ophthalmologists.

The following cases will serve briefly to illustrate how avertin can be used with benefit for ophthalmic operations.

CASE 1.—A woman 47 years of age, with a blood pressure of 300 systolic and 140 diastolic, had repeated retinal hemorrhages and incipient cataractous changes. The lenses finally became entirely opaque within a year, and it was decided to perform a preliminary iridectomy on the right eye, using local anesthesia. The patient behaved poorly during this operative procedure, moving the eyes about constantly, moving her head and talking incessantly, even though 1 grain of codeine and 3 grains of sodium amytal had been administered two hours before the operation. For the extraction of the lens eight weeks later, avertin was given as previously outlined. The patient was brought to the operating room in a deep, sound sleep. A mixture of pontocaine hydrochloride and epinephrine hydrochloride was instilled into the eye, and procaine hydrochloride was injected according to

6. Goldschmidt, E. F., and Harvey, S. C.: Rectal Administration of Tribromethanol: Its Use Abroad. *Am. J. Surg.* 18:467-477 (Dec.) 1932.

the method of Van Lint for control of the lids. The operation was performed with extreme ease, and all necessary toilet of the wound was leisurely carried out. Irrigation of remnants of the lens was continued until the pupil was black. There was no hurry, no tension or no fear of the patient's "upsetting the apple cart." The patient slept soundly for six hours in her room and awoke entirely refreshed. The next day she had no recollection of the operation.

CASE 2.—A child 7 years old was subjected to recession of the internal rectus muscle and resection of the external rectus muscle of the right eye under ether anesthesia. Sutures of 00 plain catgut were used. Five days after the operation it was noticed that the right eye was divergent and could not be brought beyond the midline. The child had been controlled with great difficulty while induction of the anesthesia was being carried out. After the operation she was plainly upset and intolerant of both nurses and doctors. It was decided to reattach the internal rectus muscle and to use avertin anesthesia reenforced by nitrous oxide and ether. The child fell asleep in her room and was brought to the operating room in a deep sleep. After the operation she slept soundly for eight hours and on awaking did not remember the operation. Her attitude toward the nurses and doctors was friendly, and she volunteered the information that she did not know she had been operated on again. Incidentally, it is of interest to report here that the sutures of 00 plain catgut were almost entirely absorbed within five days after the original operation. For the reattachment, sutures of 000 chromatic catgut were used, and this time there was no slipping of the muscle.

CASE 3.—A man aged 62 had had chronic congestive glaucoma of the left eye for nine months. When he was examined, an operation was advised. He was brought to the operating room under the influence of avertin, and a mixture of pontocaine hydrochloride and epinephrine hydrochloride was instilled into the eye. A trephine operation was performed with complete ease. The patient slept throughout the entire operative procedure. Not once was there any reaction which might indicate that he was experiencing any pain. When the iris prolapsed and was excised there was no wincing. He slept soundly for six hours after the operation and on awaking had to be reassured that the operation had already been performed.

CASE 4.—A man aged 40 had an acute purulent dacryocystitis, which was incised and drained externally. Three weeks later, when healing was complete, the left lacrimal sac was removed, avertin anesthesia being used. A mixture of procaine hydrochloride and epinephrine hydrochloride was injected into the region of the lacrimal sac exactly as if local anesthesia were to be used for the operation. Even though there had been a recent acute inflammation of the sac, the bleeding was minimal, so that the suction apparatus was not needed. There was no evidence of any pain throughout the entire procedure. The patient was allowed to go home two days after the operation.

CASE 5.—A woman aged 72 was admitted to the hospital with hypopyon keratitis in an eye with long-standing absolute glaucoma. Evisceration of the eye was done with the patient under avertin anesthesia, local instillation of pontocaine hydrochloride and epinephrine hydrochloride plus the subconjunctival injection of a few minims of 4 per cent solution of cocaine hydrochloride being used for reenforcement. There was no evidence of pain throughout the procedure. The patient slept for ten hours after the operation and was sent home three days later.

Whenever local anesthesia has been contraindicated at the Institute of Ophthalmology of the Presbyterian Hospital avertin has been the

anesthetic of choice for several years. According to information obtained from Dr. John Wheeler, which I am using with his permission, between 35 and 40 patients a month are operated on under avertin anesthesia. It is used for operations on muscles, for plastic operations, for operations for detachment of the retina and for enucleation both in adults and in children over 5 years of age. It is used for younger children only when specially requested by the surgeon. At times, of course, avertin must be reenforced with nitrous oxide and a minimal amount of ether.

At the Herman Knapp Memorial Eye Hospital and at the Brooklyn Eye and Ear Hospital it has been used only in isolated cases. At the Mount Sinai Hospital and the Manhattan Eye, Ear and Throat Hospital this anesthetic has been extremely useful for operations on the eye and is used in selected cases, sometimes being reenforced with nitrous oxide and an extremely small amount of ether.

NET AVERAGE YEARLY CHANGES IN REFRACTION OF ATROPINIZED EYES FROM BIRTH TO BEYOND MIDDLE LIFE

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Most studies of the changes in the refraction of the eye lack both accuracy and mass of observation. There are two notable exceptions. Steiger¹ in 1913 studied hundreds of Swiss school children between 6 and 11 years of age and developed therefrom his biologic theory of inheritance of states of refraction and the changes which take place in the eyes of growing children. The refraction was determined by the "manifest" method, without cycloplegia, and his conclusions are open to criticism on this score. The second study was made by Kempf, Jarman and Collins² for the United States Public Health Service in 1928 on the homotropinized eyes of 1,860 school children, and the results should therefore be more accurate than those of Steiger. A more recent study of the problems connected with defective vision in school children was made on the homotropinized eyes of 2,625 children by twenty-two observers for the Committee of Inquiry of the Great Britain Board of Education.³ The report contains a comment on the considerable disparity in the work of the individual observers, although they were well trained men.

In all of these studies, however, the refraction of a group of persons of a given age is compared with the refraction of another group of persons a year older or younger, and the difference between the two is looked on as the change which probably takes place between one age and another.

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From the Max Epstein Dispensary and Billings Hospital, School of Medicine, University of Chicago.

1. Steiger, A.: *Die Entstehung der sphärischen Refractionen des Auges*, Berlin, S. Karger, 1913.

2. Kempf, G. A.; Jarman, B. L., and Collins, S. D.: *A Special Study of the Vision of School Children*, Pub. Health Rep. 43:1713 (July 6) 1928. Kempf, G. A.; Collins, S. D., and Jarman, B. L.: *Refractive Errors in the Eyes of Children as Determined by Retinoscopic Examination with a Cycloplegic*, Bulletin 182, Treasury Department, United States Public Health Service, 1929.

3. *Defective Vision in School Children*, Report of the Committee of Inquiry, Great Britain Board of Education, London, His Majesty's Stationery Office, 1931.

Actually these deductions may be correct or nearly correct, for statisticians state that considerable masses of data minimize moderate deviations in individual data and render deductions relatively reliable. Yet such studies are in the nature of things inaccurate in comparison with data obtained on the same person, studied year after year.

In the present paper, therefore, an attempt is made to meet the requirements both of accuracy and of mass of observation. The paper is concerned solely with the matter of the net average yearly changes in static refraction in atropinized eyes from birth to the end of the fifty-first year. It has nothing to do with particular states of refraction (hyperopia, myopia or astigmatism). At the outset it is frankly stated that the mass of data after about the thirty-fifth year of life is inadequate for safe deductions (few patients submit to a second test with atropine after, say, 35) and that a record of changes between birth and the end of the first year of life is lacking because atropine has not been used a second time in the first year of life. The data between the second and the thirty-fifth year of life inclusive are, however, considerable (8,419 observations).

The claim for greater accuracy is based on the greater exactness of determinations of refraction under atropine than under homatropine or scopolamine or without cycloplegia. In his study Bothman⁴ demonstrated beyond question that atropine is a better cycloplegic than homatropine. In cases of hyperopia every sixth meridian showed an increase (decrease of refraction) of 0.75 diopter or more, and in cases of myopia every seventh meridian was decreased (its refraction increased by 0.75 diopter or more). The comparison covered a series of 1,260 eyes.

The present material comprises 8,820 observed and computed changes in the refraction of one or both eyes of 1,203 persons between birth and the end of the fifty-first year. These consisted of 611 patients observed in the clinic and 592 patients from private practice.

METHOD OF OBTAINING AND CALCULATING DATA

Atropine sulfate in 1 per cent solution was used by the patient before each meal and before retiring for three and one-half days for a total of fourteen or fifteen times, depending on whether the test was made in the morning or the afternoon of the fourth day. If the patient missed one dose, the results of retinoscopy and their agreement with the results of the trial case test were usually satisfactory, but when two or more doses were omitted the results of retinoscopy were often found to be "unsatisfactory," and the drug was continued until satisfactory data were obtained. For at least 50 per cent of all patients, a second

4. Bothman, L.: Homatropine and Atropine Cycloplegia: A Comparative Study, *Arch. Ophth.* 7:389 (March) 1932.

colleague "checked" the retinoscopic findings. All retinoscopic examinations were done by persons who were at that time teaching and demonstrating retinoscopy in the ophthalmic clinics of either the University of Illinois or the University of Chicago at a time when I was actively in charge of the dispensary work of these institutions.

The presence or absence of astigmatism was taken into account only so far as a given amount of astigmatism contributed to the average of the refraction in the two principal meridians; e. g., if the vertical meridian showed a need of correction of, say, $+1.00$ and the horizontal meridian a correction of $+3.00$, the refraction was considered, for the purposes of this paper, to be $+2.00$, and so listed. Two or more such determinations of the refraction were made at intervals of one or more years for every subject, and the changes for the particular years were noted. In cases in which the first retinoscopic examination was made when the child was, say, between the ages of 6 and 12 months and the next examination was made before the child was 2 years old, the difference between the two was considered to be the change in refraction in the second year of life; in the same way the difference between a given refraction first determined some time between the twelfth and the twenty-fourth month of life and next determined some time between the twenty-fourth and the thirty-sixth month was considered as a change occurring in the third year of life. With the use of atropine as a cycloplegic, the reversal of the retinoscopic shadow can be determined with accuracy to a 0.25 diopter and has been recorded by my associates and me in 0.25 diopter intervals.

RESULTS

From birth to the end of the seventh year hyperopia increased (refraction decreased) in the average case. From 8 to 14 years the refraction moved toward the myopic side at a rapid rate (increased), and this increase continued, though at less than half the rate, up to the age of 20. Thereafter the amount of change was negligible, but the nature of the changes was interesting; up to the age of 33 there was a slight yearly increase of refraction (except, according to our figures, for the thirtieth year); from 34 to 42 years the change was uniformly a net average decrease, though this was slight; from 43 to 51 years inclusive it was again a slight net average increase of refraction (increase of myopia, decrease of hyperopia) in each successive year, although the amount was very slight. In tables 2 to 7 are summarized the changes in the respective age groups, year by year; in table 1 are given the data for the groups as units.

A somewhat more detailed consideration and discussion of the results in the particular age groups are given in the following paragraphs.

Decrease of Refraction from Birth to the End of the Seventh Year.—The present study of this age group was based on 1,668 retinoscopic computations and showed an increase of hyperopia (decrease of refraction) for every year in comparison with that found the year before. In the third year this change was greater than in the second, but after the third year the change in each successive year was

less. The net average decrease of refraction for the years was respectively, 0.41, 0.43, 0.27, 0.21, 0.13 and 0.02 diopter (general yearly average, 0.18 diopter).

This increase of hyperopia (decrease of refraction) is directly counter to the accepted world-wide view. Parsons⁵ said (1933): "From the statistical point of view, however, the generalization that the normal eye is hyperopic at birth and tends constantly during the early years of life toward a condition of diminished hyperopia may be regarded as true." This has not been the observation of my associates and myself. Thus, in a paper written in collaboration with Kronfeld⁶ I challenged this prevailing view on the basis of the changes in 193 eyes, each reexamined one or more times under atropine during the first five years of life; 110 eyes showed either an increase of hyperopia or no change. In 1932 Bothman,⁷ at a second determination, also found an increase of hyperopia in both meridians in 71 per cent of 248 atropin-

TABLE 1.—*Changes in Refraction on the Basis of Age Groups*

Age	Computations	Change in Diopters	Type of Change*
Birth to 7.....	1,668	0.18	Decrease
8 to 13.....	2,862	0.23	Increase
14 to 20.....	2,068	0.14	Increase
21 to 33.....	1,687	0.04	Increase
34 to 42.....	441	0.03	Decrease
43 to 51.....	94	0.03	Increase
Birth to 51.....	8,820	0.09	Increase

* Decrease means more hyperopia or less myopia; increase, less hyperopia or more myopia.

ized eyes of children under 6 years of age. Again in 1936 I⁸ found an apparent increase of hyperopia in 63 per cent of 604 eyes of children up to 9 years of age. The patients used in the present study include all those observed in the three previous studies along with additional patients, but, as stated previously, the entire material has been analyzed in a more accurate way; thus if a given subject had the first refraction test, say, at the age of 6 years but no second test before 9, the amount of change found was divided by 3, and this amount was credited to each of the respective three years. Thus a large but legitimate increase in

5. Parsons, John: Developmental Myopia and the Treatment of Myopes, *Lancet* 2:795 (Oct. 17) 1933.

6. Brown, E. V. L., and Kronfeld, P. C.: Refractive Curve in the U. S. A. with Special Reference to Changes in the First Two Decades, *Compt. rend. Concilium Ophth.* 13:87, 1929.

7. Bothman, L.: Refraction Changes in the Eyes of Children Under Six Years of Age, *Arch. Ophth.* 7:294 (Feb.) 1932.

8. Brown, E. V. L.: Apparent Increase of Hyperopia up to the Age of Nine Years, *Am. J. Ophth.* 19:1106 (Dec.) 1936.

the number of deduced observations was obtained for study along with the other data obtained from the comparison of the refraction in two subsequent years.

In over two thirds of the children under 8 years of age (1,213 of 1,668 observations) strabismus was present, but neither its presence or absence nor the sex of the patient seemed to modify significantly this trend toward a decrease of refraction. Decrease of refraction was present in the group as a whole throughout each year, in male and female alike in each year and in strabismic and in nonstrabismic eyes (chart 1). I therefore again seriously challenge the prevailing view that decrease of hyperopia is the rule in the early years of life and present further evidence that a decrease of refraction (increase of hyperopia) is the rule up to the end of the seventh year of life (chart 2).

Beginning with the eighth year of life, our findings show that the net average change was no longer one toward more hyperopia but was one toward less hyperopia or more myopia. From the age of 8 to 13 inclusive the net yearly averages of these increases in refraction were: 0.10 diopter in the eighth year, 0.19 in the ninth, 0.27 in the tenth, 0.27 in the eleventh, 0.28 in the twelfth and 0.29 in the thirteenth. The net average change for the period was an increase of refraction of 0.23 diopters per year.

Slower Increase of Refraction from 14 to 20.—In our present data the rate of increase of refraction toward myopia decreased markedly after 13 years; indeed up to the age of 20 the rate is only slightly more than half the average amount found between 8 and 13 years (0.14 vs. 0.23 diopter per year). The amount of the net yearly increase for the average eye in the successive years, 14 to 20, was as follows (table 4): 0.23 diopter in the fourteenth year, 0.17 in the fifteenth, 0.17 in the sixteenth, 0.15 in the seventeenth, 0.10 in the eighteenth, 0.10 in the nineteenth and 0.08 in the twentieth.

Cessation of Increase of Myopia at 20.—The material covering the twenty-first to the thirty-third year inclusive comprised 1,687 observations and calculations. Net (average) increases of refraction were noted in every year except in the thirtieth, when the figures showed a slight net decrease (0.0001 diopter for the average eye). The yearly changes were slight, e. g., 0.05, 0.06, 0.07, 0.05, 0.04, 0.02, 0.02, 0.04, 0.005, 0.0001 (decrease in the thirtieth year), 0.02, 0.02 and 0.02 diopter per year in the successive years. The net average change for the group as a whole was an increase of refraction of only 0.04 diopter per year (table 5). At this slow rate it would require twelve years to effect an increase of 0.5 diopter in myopia or a decrease of 0.5 diopter in hyperopia, and this is, of course, practically a negligible change. There was no evidence whatever in this series that myopia regularly progresses after the age of 20.

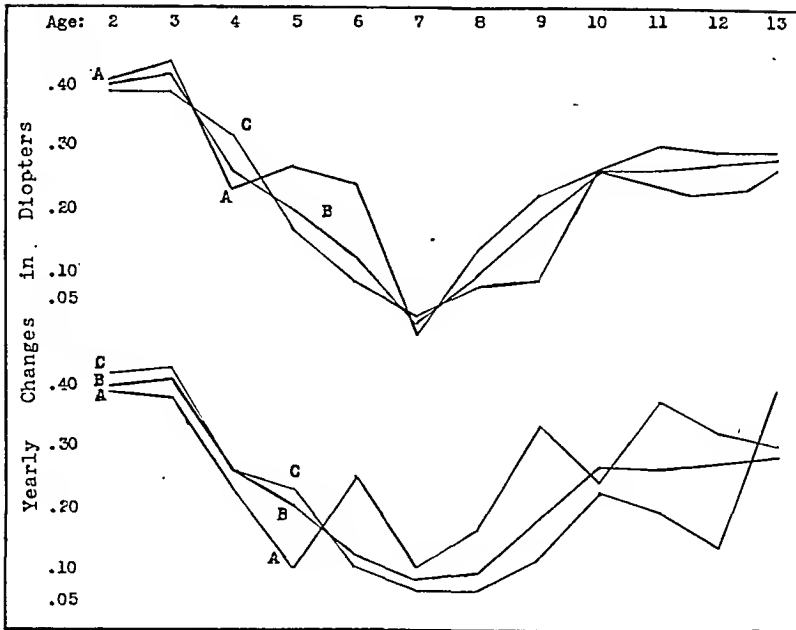


Chart 1.—The upper three curves show the yearly changes in the eyes of the females as compared with those in the eyes of the males for an age group of from 2 to 13 years. *A* is the curve for the females; *B*, the curve for the entire group, and *C*, the curve for the males. The lower three curves show the yearly changes in strabismic eyes as compared with those in nonstrabismic eyes for the same age group. *A* is the curve for the nonstrabismic eyes; *B*, the curve for all eyes, and *C*, the curve for the strabismic eyes.

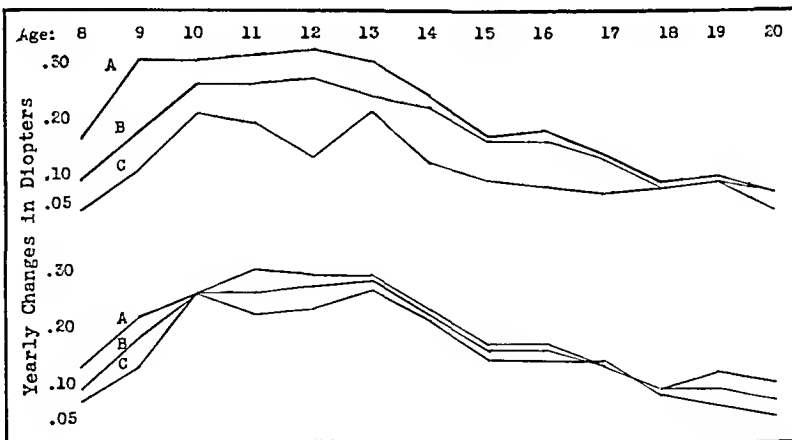


Chart 2.—The upper three curves show the yearly changes in strabismic eyes as compared with those in nonstrabismic eyes for an age group of from 8 to 20 years. *A* is the curve for the nonstrabismic eyes; *B*, the curve for all eyes, and *C*, the curve for the strabismic eyes. The lower three curves show the yearly changes in the eyes of females as compared with those in the eyes of males for the same age group. *A* is the curve for the females; *B*, the curve for the entire group, and *C*, the curve for the males.

TABLE 2.—*Changes in Refraction from Birth to the End of the Seventh Year*

Year of Life		Male												Female												Male and Female, With and Without Strabismus	
		Without Strabismus				With Strabismus				Totals				Without Strabismus				With Strabismus				Totals					
		Number of Computations	Average Change and Type of Change	Number of Computations	Average Change and Type of Change	Number of Computations	Average Change and Type of Change	Number of Computations	Average Change and Type of Change	Number of Computations	Average Change and Type of Change	Number of Computations	Average Change and Type of Change	Number of Computations	Average Change and Type of Change	Number of Computations	Average Change and Type of Change	Number of Computations	Average Change and Type of Change	Number of Computations	Average Change and Type of Change						
2d	Increases	0	....	9	0.90	9	0.90	4	0.41	4	0.90	8	0.66	17	0.72											
	Decreases	0	....	25	0.90	25	0.90	8	0.26	25	0.80	33	0.60	58	0.76											
	No change	0	....	2	....	2	....	12	0.04 d	31	0.53 d	43	0.42 d	4	....											
3d	Increases	...	....	...	....	...	....	4	0.24	4	0.52	8	0.38	20	0.38						
	Decreases	4	0.41	12	0.38	12	0.38	12	0.58	67	0.37	79	0.37	132	0.38												
	No change	0	0.41 d	8	0.40 d	8	0.40 d	0	0.38 d	7	0.46 d	7	0.45 d	15	0.62												
4th	Increases	1	0.25	11	0.19	12	0.20	5	0.20	32	0.37	37	0.35	49	0.31												
	Decreases	9	0.33	53	0.30	62	0.38	12	0.37	84	0.51	96	0.41	158	0.40												
	No change	1	0.30 d	10	0.33 d	11	0.33 d	1	0.15	12	0.24 d	13	0.24 d	24	0.27 d												
5th	Increases	19	0.21	36	0.16	55	0.18	44	0.15	44	0.31	88	0.24	114	0.21												
	Decreases	48	0.28	82	0.38	131	0.32	150	0.20 d	150	0.48	167	0.47	298	0.41												
	No change	9	0.13 d	15	0.19 d	24	0.17 d	18	0.38	20	0.24 d	38	0.28 d	45	0.21												
6th	Increases	10	0.28	44	0.28	54	0.28	40	0.25	40	0.34	80	0.32	117	0.30												
	Decreases	18	0.21	55	0.43	73	0.38	13	0.44	13	0.48	26	0.41	188	0.42												
	No change	1	0.03 d	14	0.10 d	15	0.09 d	80	0.32 d	80	0.13 d	207	0.25 d	43	0.13 d												
7th	Increases	28	0.30	46	0.29	74	0.28	50	0.46	50	0.39	90	0.42	161	0.39												
	Decreases	23	0.25	62	0.37	85	0.35	78	0.43	78	0.40	97	0.41	182	0.37												
	No change	5	0.05 d	116	0.07 d	121	0.03 d	21	0.16 d	21	0.08 d	215	0.0005 d	41	0.18 d												

TABLE 3.—Changes in Refraction from the Eighth to the End of the Thirteenth Year

Year of Life	Type of Change	Male						Female						Male and Female, With and Without Strabismus		
		Without Strabismus			With Strabismus			Without Strabismus			With Strabismus					Totals
		Number of Computations	Average Change and Type of Change	Number of Computations	Average Change and Type of Change	Totals	Number of Computations	Average Change and Type of Change	Number of Computations	Average Change and Type of Change	Totals	Number of Computations	Average Change and Type of Change	Number of Computations	Average Change and Type of Change	Totals	Net Average Yearly Change and Type of Change
8th	Increases	51	0.37	67	0.31	118	0.28	69	0.38	86	0.36	155	0.37	273	0.35	
	Decreases	36	0.25	34	0.41	70	0.33	16	0.14	53	0.33	69	0.29	139	0.31	
	No change	9		16		25		14		18		32		57		
	Totals	96	0.10	117	0.06	213	0.08	99	0.24	157	0.09	256	0.14	469	0.10	
9th	Increases	104	0.38	74	0.30	178	0.35	113	0.50	81	0.38	194	0.45	109	0.40	
	Decreases	22	0.22	29	0.40	51	0.32	20	0.25	38	0.28	58	0.27	372	0.27	
	No change	12		12		24		11		17		28		52		
	Totals	138	0.25	115	0.09	253	0.14	144	0.36	136	0.15	280	0.23	533	0.19	
10th	Increases	79	0.46	65	0.46	144	0.46	115	0.47	71	0.40	186	0.44	330	0.40	
	Decreases	23	0.19	20	0.29	43	0.21	20	0.24	25	0.29	45	0.27	88	0.29	
	No change	10		11		21		13		14		27		48		
	Totals	112	0.29	96	0.25	208	0.27	148	0.33	110	0.19	258	0.27	466	0.27	
11th	Increases	104	0.43	49	0.26	153	0.38	137	0.37	68	0.39	205	0.38	358	0.37	
	Decreases	14	0.19	24	0.31	38	0.27	16	0.26	18	0.25	34	0.25	72	0.26	
	No change	10		6		16		10		10		20		36		
	Totals	128	0.28	79	0.16	207	0.23	163	0.35	96	0.23	259	0.31	466	0.27	
12th	Increases	117	0.44	37	0.29	154	0.40	160	0.43	47	0.35	207	0.41	361	0.41	
	Decreases	29	0.18	16	0.31	45	0.23	7	0.28	17	0.20	24	0.23	69	0.23	
	No change	11		4		15		17		7		24		39		
	Totals	157	0.29	57	0.10	214	0.24	184	0.36	71	0.18	255	0.30	469	0.28	
13th	Increases	126	0.41	39	0.35	165	0.40	162	0.43	39	0.31	201	0.41	366	0.40	
	Decreases	31	0.25	3	0.07	34	0.23	13	0.32	16	0.25	29	0.28	63	0.26	
	No change	7		3		10		13		4		17		27		
	Totals	164	0.26	45	0.30	209	0.27	188	0.35	59	0.14	247	0.30	456	0.29	

TABLE 4.—*Changes in Refraction from the Fourteenth to the Twentieth Year Inclusive*

Year of Life	Type of Change	Male						Female						Male and Female, With and Without Strabismus	
		Without Strabismus			Totals			Without Strabismus			Totals				
		Strabismus			Totals			Strabismus			Totals				
		Number of Computations	Average Change and Type of Change	Number of Computations	Average Change and Type of Change	Number of Computations	Average Change and Type of Change	Number of Computations	Average Change and Type of Change	Number of Computations	Average Change and Type of Change	Number of Computations	Average Change and Type of Change		
14th	Increases	121	0.38	0.30	149	0.37	0.37	145	0.38	0.06	32	0.06	0.32	326	0.34
	Decreases	20	0.22	0.64	21	0.21	0.21	17	0.20	0.10	8	0.10	0.17	46	0.08
	No change	10			12			15			3			30	
	Totals	151	0.21 i	0.27 i	182	0.22 i	0.22 i	177	0.29 i	0.03 i	43	0.03 i	0.21 i	402	0.23 i
15th	Increases	103	0.28	0.19	118	0.27	0.27	133	0.34	0.24	22	0.24	0.32	273	0.29
	Decreases	21	0.27	0.08	29	0.24	0.24	21	0.47	0.14	12	0.14	0.35	62	0.30
	No change	12			15			21			3			30	
	Totals	139	0.16 i	0.11 i	162	0.15 i	0.15 i	175	0.20 i	0.10 i	37	0.10 i	0.18 i	374	0.17 i
16th	Increases	88	0.22	0.19	107	0.21	0.21	132	0.28	0.24	24	0.24	0.27	263	0.26
	Decreases	16	0.16	0.26	19	0.18	0.18	16	0.25	0.12	8	0.12	0.21	43	0.19
	No change	8			9			24			3			26	
	Totals	112	0.15 i	0.18 i	135	0.15 i	0.15 i	172	0.19 i	0.14 i	35	0.14 i	0.18 i	342	0.17 i
17th	Increases	84	0.24	0.14	93	0.23	0.23	111	0.22	0.23	21	0.23	0.22	225	0.24
	Decreases	16	0.20	0.26	19	0.21	0.21	21	0.12	0.28	7	0.28	0.16	47	0.18
	No change	8			8			14			1			23	
	Totals	108	0.16 i	0.04 i	120	0.15 i	0.15 i	146	0.15 i	0.10 i	29	0.10 i	0.14 i	295	0.15 i
18th	Increases	76	0.20	0.15	86	0.19	0.19	88	0.19	0.17	10	0.17	0.18	184	0.19
	Decreases	23	0.21	0.12	26	0.20	0.20	22	0.16	0.09	4	0.09	0.15	52	0.17
	No change	13			14			10			1			25	
	Totals	112	0.09 i	0.08 i	126	0.09 i	0.09 i	120	0.11 i	0.09 i	15	0.09 i	0.10 i	261	0.10 i
19th	Increases	55	0.18	0.15	62	0.18	0.18	68	0.22	0.10	8	0.10	0.21	138	0.19
	Decreases	22	0.16	0.06	24	0.15	0.15	17	0.11	0.10	6	0.10	0.11	37	0.11
	No change	14			15			5			1			71	
	Totals	91	0.07 i	0.09 i	101	0.07 i	0.07 i	90	0.15 i	0.01 i	15	0.01 i	0.13 i	206	0.10 i
20th	Increases	46	0.17	0.16	52	0.17	0.17	53	0.21	0.07	8	0.07	0.19	113	0.18
	Decreases	25	0.17	0	25	0.17	0.17	18	0.10	0.09	4	0.09	0.10	47	0.13
	No change	12			13			13			2			28	
	Totals	83	0.04 i	0.14 i	90	0.05 i	0.05 i	84	0.12 i	0.01 i	14	0.01 i	0.11 i	188	0.08 i

TABLE 5.—Changes in Refraction from the Twenty-First to the Thirty-Third Year Inclusive

Year of Life	Type of Change	Male						Female						Male and Female, With and Without Strabismus		
		Without Strabismus			Totals			Without Strabismus			Totals			Number of Computations	Average Yearly Change and Type of Change	Net Average Yearly Change and Type of Change
		Number of Computations	Average Change and Type of Change	Number of Computations	Average Change and Type of Change	Number of Computations	Average Change and Type of Change	Number of Computations	Average Change and Type of Change	Number of Computations	Average Change and Type of Change	Number of Computations	Average Change and Type of Change			
21st	Increases	37	0.13	5	0.12	42	0.13	52	0.14	6	0.11	58	0.14	100	0.13	
	Decreases	24	0.14	0	0	24	0.14	7	0.27	2	0.02	9	0.21	33	0.16	
	No change	11		..		11		12		4		16		27		
	Totals	72	0.02 i	5	0.02 i	77	0.03 i	71	0.08 i	12	0.05 i	83	0.07 i	160	0.05 i	
22d	Increases	43	0.16	2	0.12	45	0.16	52	0.15	2	0.11	54	0.15	99	0.14	
	Decreases	23	0.12	0	0	23	0.12	19	0.10	3	0.14	22	0.12	45	0.11	
	No change	2		..		2		11		8		19		21		
	Totals	68	0.03 i	2	0.12 i	70	0.06 i	82	0.07 i	13	0.26 d	95	0.06 i	165	0.06 i	
23d	Increases	41	0.19	2	0.12	43	0.19	51	0.12	2	0.04	53	0.12	96	0.15	
	Decreases	25	0.13	0	0	25	0.13	17	0.07	3	0.14	20	0.08	45	0.12	
	No change	4		..		4		8		6		14		18		
	Totals	70	0.06 i	2	0.12 i	72	0.07 i	76	0.06 i	11	0.03 d	87	0.05 i	159	0.07 i	
24th	Increases	45	0.19	2	0.12	47	0.19	52	0.12	2	0.39	54	0.13	101	0.15	
	Decreases	26	0.10	0	0	26	0.10	20	0.16	3	0.14	23	0.16	49	0.13	
	No change	8		..		8		7		3		10		18		
	Totals	79	0.08 i	2	0.12 i	81	0.07 i	79	0.04 i	8	0.05 i	87	0.04 i	168	0.05 i	
25th	Increases	39	0.18	1	0.09	40	0.18	47	0.11	2	0.11	49	0.11	89	0.14	
	Decreases	24	0.09	1	0.14	25	0.09	20	0.12	2	0.22	22	0.13	47	0.11	
	No change	10		..		10		7		4		11		21		
	Totals	73	0.07 i	2	0.03 d	75	0.05 i	74	0.04 i	8	0.03 d	82	0.03 i	137	0.04 i	
26th	Increases	28	0.09	3	0.09	31	0.09	32	0.12	2	0.12	34	0.12	65	0.11	
	Decreases	27	0.12	0	0.12	27	0.12	13	0.08	1	0.01	14	0.08	41	0.10	
	No change	10		3		13		4		2		6		19		
	Totals	65	0.01 d	6	0.05	71	0.006 d	49	0.06 i	5	0.06 i	54	0.06 i	125	0.02 i	

[illegible]

TABLE 6.—Changes in Refraction from the Thirty-Fourth to the Forty-Second Year Inclusive

Year of Life	Type of Change	Male						Female						Male and Female, With and Without Strabismus	
		Without Strabismus			Totals			Without Strabismus			With Strabismus			Number of Computations	Net Average Yearly Change and Type of Change
		Number of Computations	Average Change and Type of Change	Number of Computations	Average Change and Type of Change	Number of Computations	Average Change and Type of Change	Number of Computations	Average Change and Type of Change	Number of Computations	Average Change and Type of Change	Number of Computations	Average Change and Type of Change		
34th	Increases	8	0.17	0	0	8	0.17	15	0.09	0	0	15	0.09	23	0.11
	Decreases	1	0.02	0	0	1	0.02	28	0.07	4	0.13	32	0.08	33	0.07
	No change	2				2		9		1		10		12	
	Totals	11	0.12 i	0	0	11	0.12 i	52	0.02 d	5	0.10 d	57	0.02 d	68	0.003 d
35th	Increases	0	0	0	0	0	0	18	0.11	0	0	18	0.11	37	0.12
	Decreases	0	0	0	0	0	0	37	0.12	0	0	37	0.12	18	0.11
	No change	0				0		11				11		11	
	Totals	0	0	0	0	0	0	66	0.04 d	0	0	66	0.04 d	66	0.04 d
36th	Increases	4	0.05	0	0	4	0.05	14	0.12	0	0	14	0.12	18	0.10
	Decreases	5	0.31	0	0	5	0.31	26	0.10	1	0.12	27	0.10	32	0.13
	No change	5				5		5				5		10	
	Totals	14	0.10 d	0	0	14	0.10 d	45	0.02 d	1	0.12 d	46	0.02 d	60	0.04 d
37th	Increases	0	0	0	0	0	0	17	0.08	0	0	17	0.08	17	0.08
	Decreases	2	0.71	0	0	2	0.71	24	0.07	0	0	24	0.07	26	0.12
	No change	1				1		6				6		7	
	Totals	3	0.47 d	0	0	3	0.47 d	47	0.007 i	0	0	47	0.007 i	50	0.02 d
38th	Increases	0	0	0	0	0	0	15	0.06	0	0	15	0.06	15	0.06
	Decreases	2	0.72	0	0	2	0.72	23	0.07	0	0	23	0.07	25	0.12
	No change	1				1		8				8		9	
	Totals	3	0.48 d	0	0	3	0.48 d	46	0.01 d	0	0	46	0.01 d	49	0.04 d
39th	Increases	0	0	0	0	0	0	14	0.06	0	0	14	0.06	14	0.06
	Decreases	2	0.80	0	0	2	0.80	19	0.07	0	0	19	0.07	21	0.12
	No change	0				0		9				9		9	
	Totals	2	0.60 d	0	0	2	0.60	42	0.01 d	0	0	42	0.01 d	44	0.04 d
40th	Increases	0	0	0	0	0	0	15	0.10	1	0.31	16	0.11	16	0.11
	Decreases	1	0.83	0	0	1	0.83	14	0.10	0	0	14	0.10	15	0.15
	No change	1				1		10		1		11		12	
	Totals	2	0.42 d	0	0	2	0.42 d	39	0.003 d	2	0.16 i	41	0.01 i	43	0.01 d
41st	Increases	3	0.27	0	0	3	0.27	8	0.12	1	0.31	9	0.14	12	0.17
	Decreases	2	0.44	0	0	2	0.44	13	0.17	0	0	13	0.17	15	0.20
	No change	1				1		6				6		7	
	Totals	6	0.01 d	0	0	6	0.01 d	27	0.05 d	1	0.31 i	28	0.03 d	34	0.03 d
42d	Increases	0	0	0	0	0	0	12	0.11	0	0	12	0.11	12	0.17
	Decreases	2	0.42	0	0	2	0.42	11	0.09	0	0	11	0.09	11	0.15
	No change	0				0		4				4		4	
	Totals	2	0.42 d	0	0	2	0.42	27	0.01 d	0	0	27	0.01 i	27	0.02 d

Decrease of Refraction Between 34 and 42.—Only 441 observations formed the basis of the study of this age group. But, surprisingly, the net average change consisted of a decrease of refraction (more hyperopia or less myopia) for each and every year without exception. The net amounts were again slight, e. g., only 0.003, 0.04, 0.04, 0.02, 0.04, 0.04, 0.01, 0.03 and 0.02 diopter (an average of 0.03 diopter) for the successive years (table 6).

Slight Increase of Refraction Between 43 and 51.—In this last period only 94 observations were made. But in every year the trend of the previous age group was reversed, and a slight increase was noted. The findings were, respectively, 0.04, 0.03, 0.01, 0.09, 0.02, 0.01, 0.04, 0.08 and 0.08 diopter (average, 0.03) of net average increase of refraction for the successive years (table 7). In view of the small number of observations, one cannot, of course, be at all confident of the reliability of conclusions.

Interpretation of the Average Changes in the Various Periods.—In my opinion the decrease of hyperopia noted through the first seven years of life is not due to less effective cycloplegia in the earliest years. It could be due to (1) a decrease in the curvature of the cornea, (2) a decrease in the curvature of the surfaces of the lens and (3) a relative backward displacement of the lens. It does not seem that a decrease in the refraction of the aqueous, lens or vitreous could play any part. It is inconceivable that the eye becomes shorter. A small beginning has been made by us toward a comparison of the curvature of the cornea in a few persons in the series with that of the same person at a later age, but the data are not sufficient to warrant a report or comment. Steiger made a study of the corneal curvature years ago, but it consisted of a comparison of changes found in a given age group with those in what must have been another group of persons at a later age. No satisfactory method of measuring the curvature of the posterior or anterior surface of the lens has been devised. That of Tscherning has been used for an extended study by Tron,⁹ but the shortcomings and entire inadequacy of the method have been pointed out by Gullstrand and by Nordenson.¹⁰ Katz, assisted by Ledoux,¹¹ in my clinic, has devised a method for estimating the length of the eye intra vitam. An opaque substance is injected behind the eye, a

9. Tron, E.: Variationsstatistische Untersuchungen über Refraktion, Arch. f. Ophth. 122:1 (May) 1929.

10. Nordenson, J. E.: Die Untersuchungsmethoden, in von Graefe, A., and Saemisch, E. T.: Handbuch der gesamten Augenheilkunde, ed. 3, Leipzig, Wilhelm Engelmann, 1925, vol. 2, p. 215.

11. Katz, D., and Ledoux, A. C.: Measurement (Roentgenometry) of Antero-Posterior Diameter of the Eyeball in Situ Correlated with Micrometer Measurement Following Enucleation, Am. J. Ophth. 18:914 (Oct.) 1935.

TABLE 7.—Changes in Refraction from the Forty-Third to the Fifty-First Year Inclusive

Year of Life	Type of Change	Male						Female						Male and Female, With and Without Strabismus		
		Without Strabismus			With Strabismus			Without Strabismus			With Strabismus			Number of Computations	Average Change and Type of Change	Net Average Yearly Change and Type of Change
		Number of Computations	Average Change and Type of Change	Number of Computations	Average Change and Type of Change	Totals		Number of Computations	Average Change and Type of Change	Number of Computations	Average Change and Type of Change	Totals				
43d	Increases	0	0	0	0	0		11	0.23	0	0	11	0.23	11	0.23	
	Decreases	2	0.41	0	0	0.44		7	0.13	0	0	7	0.13	9	0.19	
	No change	0	0	0	0	0		3	0	0	0	3	0	3	0.04 i	
	Totals	2	0.44 d	2	0	0.44 d		21	0.08 i	0	0	21	0.08 i	23	0.10	
44th	Increases	0	0	0	0	0		11	0.10	0	0	11	0.10	11	0.10	
	Decreases	0	0	0	0	0		4	0.15	0	0	4	0.15	4	0.15	
	No change	0	0	0	0	0		2	0	0	0	2	0	2	0.03 i	
	Totals	0	0	0	0	0		17	0.03 i	0	0	17	0.03 i	17	0.03 i	
45th	Increases	0	0	0	0	0		12	0.13	0	0	12	0.13	12	0.13	
	Decreases	0	0	0	0	0		1	0.03	0	0	1	0.03	1	0.08	
	No change	1	0	1	0	0		2	0	0	0	2	0	3	0.01 i	
	Totals	1	0	1	0	0		15	0.01 i	0	0	15	0.01 i	16	0.01 i	
46th	Increases	0	0	0	0	0		5	0.14	0	0	5	0.14	5	0.14	
	Decreases	0	0	0	0	0		1	0.06	0	0	1	0.06	1	0.06	
	No change	0	0	0	0	0		1	0	0	0	1	0	1	0.09 i	
	Totals	0	0	0	0	0		7	0.09 i	0	0	7	0.09 i	7	0.09 i	
47th	Increases	0	0	0	0	0		7	0.15	0	0	7	0.15	7	0.15	
	Decreases	0	0	0	0	0		2	0.45	0	0	2	0.41	2	0.41	
	No change	0	0	0	0	0		1	0	0	0	1	0	1	0.02 i	
	Totals	0	0	0	0	0		10	0.02 i	0	0	10	0.02 i	10	0.02 i	
48th	Increases	0	0	0	0	0		7	0.08	0	0	7	0.08	7	0.08	
	Decreases	0	0	0	0	0		0	0	0	0	0	0	0	0	
	No change	0	0	0	0	0		2	0	0	0	2	0	2	0.01 i	
	Totals	0	0	0	0	0		9	0.01 i	0	0	9	0.01 i	9	0.01 i	
49th	Increases	0	0	0	0	0		4	0.09	0	0	4	0.09	4	0.09	
	Decreases	0	0	0	0	0		1	0.06	0	0	1	0.06	1	0.06	
	No change	0	0	0	0	0		2	0	0	0	2	0	2	0.04 i	
	Totals	0	0	0	0	0		7	0.04 i	0	0	7	0.04 i	7	0.04 i	
50th	Increases	2	0.03	0	0	0.03		1	0.03	0	0	1	0.03	3	0.03	
	Decreases	0	0	0	0	0		0	0	0	0	0	0	0	0	
	No change	0	0	0	0	0		0	0	0	0	0	0	0	0	
	Totals	2	0.03	0	0	0.03 i		1	0.03 i	0	0	1	0.03 i	3	0.03 i	
51st	Increases	2	0.03	0	0	0.03		0	0	0	0	0	0	2	0.08	
	Decreases	0	0	0	0	0		0	0	0	0	0	0	0	0	
	No change	0	0	0	0	0		0	0	0	0	0	0	0	0	
	Totals	2	0.03 i	0	0	0.03 i		0	0	0	0	0	0	2	0.03 i	

roentgenogram is taken and the length of the eye as a whole is measured. The method has been developed to a high degree of proved accuracy (0.1 mm.) in lower animals, which is still insufficient, along with a method for the obtaining of two accurately determinable measurements (corneal curvature and total retinoscopic refraction) for use in the calculation of the third main factor in refraction, the curvature of the lens. If greater refinement of this method can be brought about, it is clear that a real contribution can be made to the study of refraction as well as to that of other problems, as Katz pointed out. It would then be easy to prove or disprove the contention of Tron, now based on insufficient or unacceptable data, that the emmetropic and the myopic eye may be as short as 21 and 22 mm., respectively.

Myopia develops mainly during the school years, according to the adherents of both the hereditary and the environmental theory of the causation of myopia, and our findings corroborate this so far as the net average yearly changes are concerned. For example, we find no tendency in the average eye toward myopia before the age of 8 and a rapid increase of refractive change (toward less hyperopia and more myopia) from 8 to 13 years; but while the increase continues up to the age of 20 it is steadily, progressively and uniformly less in amount each year in comparison with that found the previous year. On the whole, the increase is little more than half the rate of the previous period.

In searching for the reason for this trend toward emmetropization in the group as a whole, it at once comes to mind that only one thing regularly intervenes at from 12 to 14 years of age, and that is puberty. Is it not logical to assume that just as every other cell and tissue in the body is especially vitalized by the "sex hormones" at this time (and possibly somewhat decreasingly so for the next six or eight years), so too the eye is subjected to influences which tend toward "emmetropization?"

The data on changes after the age of 20 would show that net average yearly changes are negligible to at least an age well beyond middle life. The only statement with which I am familiar concerning the age beyond which myopia does not develop is that of Salzmann to the effect that myopia does not increase beyond the age of 25. The present data would place this at 20. Between 20 and 33 years a slight net average increase was noted (0.04 diopter per year). But between 34 and 42 years the reverse was the case; i. e., there was a net average yearly decrease in each successive year, although the amount was slight (0.03 diopter, on the average) per year. Here it is conceivable that accommodation is weaker, cycloplegia more effective or both. From the age of 43 to and including the fifty-first year, a small group of 94 observa-

tions again showed an increase of refraction, slight in amount (0.09 diopter). Increase of the index of refraction of the lens may possibly account for this, though deductions are scarcely permissible from such a small number of observations. Still the change was constant for each year.

SUMMARY AND CONCLUSIONS

Two or more retinoscopic tests were made on one or both atropinized eyes of 1,203 persons at intervals one or more years apart, and on the basis of 8,820 changes computed the net average yearly changes in refraction from birth to the end of the fifty-first year have been studied.

My conclusions are that in the average person who comes to the ophthalmologist the following changes in refraction take place:

1. Hyperopia increases each year until the end of the seventh year, contrary to the generally accepted view.

2. Myopia increases and hyperopia decreases (refraction increases) rapidly from 8 to 13 years, as generally held.

3. From 14 to 20 years this increase continues each year but at a rate barely half that of the previous period. Puberty possibly tends to bring about an "emmetropization."

4. Increase of myopia after the age of 20 is practically negligible, and the average changes in refraction are of a minor amount. Increase in myopia has heretofore been held to continue to a later age. There are definite trends and reversals in the nature of these changes as follows:

- (a) Between 20 and 33 years the increase continues at a very low average yearly rate (0.04 diopter).

- (b) Between 34 and 42 years the refraction shifts to a low yearly decrease in each successive year, averaging only 0.03 diopter; this is possibly due to the weakening of accommodation.

- (c) Between 43 and 51 years there is again a slight yearly increase in each successive year, averaging 0.09 diopter, possibly due to an increase in the index of refraction of the lens.

MOLDED CONTACT LENSES

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The molded contact lens is rapidly advancing from an experimental status to that of a device of proved worth. This type of lens represents the ideal conception of a perfect contact lens because the scleral portion can be molded to the shape of each patient's sclera, with allowance for the play of the extrinsic muscles and the forces exerted by the eyelids, maximum comfort thus being insured. At the same time the corneal portion can be optically ground to correct ametropia with exactness, maximum visual acuity being insured. Lenses can be made in various sizes to meet individual requirements. The limits in this respect are governed only by the size of the cast provided. The finished lens is made of one piece of chemically resistant hard crown glass with a refractive index of 1.516.

Data obtained as a result of making casts of approximately 250 eyes not easily fitted with ground contact lenses have made it possible to determine why these particular eyes were difficult to fit. It has also revealed a probable reason for the wide differences of individual tolerance when the fit of the scleral portion of the ground contact lens is good.

It is my opinion that the primary difficulty in obtaining comfort with a contact lens is due to pressure at the limbus, particularly nasally and temporally. This opinion is borne out by careful measurement of horizontal and vertical corneal diameters as seen on positive plaster casts of the anterior portion of the eye. It is extremely difficult to measure the diameter of the cornea from limbus to limbus on the eye itself. When this measurement was attempted in a number of instances the results varied from those obtained from a casting by as much as 3 mm. However, castings of the eye show a clear and defined line of demarcation about the entire circumference of the cornea. This furrow, called the external scleral sulcus, is seen as a depression due to the difference of curvature between the scleral and the corneal segment.

Contrary to the measurements generally accepted, the average diameters of the corneas measured were 12 and 13.55 mm., the smallest and longest horizontal diameters being 11.5 and 15.25 mm., respectively. Vertically, the range was from 10.5 to 13.5 mm. The accompanying table shows the proportion of the many variations measured. It can be

seen at a glance that most of the corneas measured from 11.5 to 12.5 mm. vertically and from 13 to 14 mm. horizontally. All differences of 0.25 mm. are recorded as in the division smaller, to avoid overstatement.

When it is remembered that the corneal portion of the ground Zeiss contact lens is 12 mm. in diameter, is it any wonder that a large number of patients with lenses with well fitted scleral portions are unable to wear them with comfort?

The following case report will serve to exemplify this situation: A young woman whose history revealed no contraindication to the use of contact lenses obtained an exceptionally good fit in the scleral portion with Zeiss trial contact lenses. During the trial period for a test of tolerance some inflammation was observed at the end of half an hour's wear. Examination with fluorescein showed clearance of the

Measurements of Two Hundred Corneas from Casts

		Vertical Diameter of Cornea in Millimeters							Total No.	Percentage
		10.5	11.0	11.5	12.0	12.5	13.0	13.5		
Horizontal diameter of cornea in millimeters	11.5	1	..	..	..	..	..	..	1	0.5
	12.0	..	6	2	..	..	..	..	8	4.0
	12.5	3	5	6	3	..	..	..	17	8.5
	13.0	..	5	11	18	4	..	..	38	19.0
	13.5	2	..	7	38	14	1	..	62	31.0
	14.0	..	..	3	25	14	6	..	48	24.0
	14.5	..	..	..	3	8	4	1	16	8.0
	15.0	..	..	..	2	2	3	3	10	5.0
Total.....		6	16	29	89	42	14	4		
Percentage.....		3	8	14.5	44.5	21	7	2		
Average diameters of cornea.....									12 and 13.55 mm.	
Average difference between vertical and horizontal diameter.....									1.55 mm.	

cornea and some pressure at the limbus. As the ciliary body was injected, this pressure was considered the cause of the irritation. The horizontal diameter of each cornea as measured with a ruler was 13 mm., and the patient was advised to order continuous transition lenses, which should clear a cornea of this width and therefore relieve the irritation observed.

The lenses were subsequently delivered, and within a week the patient reported inability to wear them over half an hour. She was advised to try further to establish a tolerance. At the end of two months the same situation existed, and the patient reported that she must be one of the class of patients who could not wear contact lenses.

In an effort to do everything possible to provide the patient with a comfortable lens, it was advised that she have molds made of her eyes for the newer type of lens. Molds and casts of the eyes were successfully made. Careful measurements of the casts revealed corneas 12.5 by 14.5 mm. in diameter. The reason for lack of comfort was then obvious, and molded lenses were ordered.

On arrival, the molded lenses were placed on the patient's eyes with a great deal of interest and expectation of a successful overcoming of her difficulties. Much to her satisfaction the lenses were worn for one hour, and in a reasonable length of time an actual tolerance was established.

A satisfactory fit with a ground contact lens on a patient having a wide cornea is probably due to a symmetrical flattening of the globe as it approaches the limbus. This prevents the corneal portion and the scleral section immediately about it from coming in contact with the sclera, limbus or cornea.

The second most important factor in the inability to obtain a comfortable fit with a contact lens is irregularity of curvature of the sclera. When the irregularity is symmetrical on the two sides of the horizontal meridian, it varies from just enough to cause discomfort to as much as 1 mm. or more difference in radius between axes at 90 degrees to one

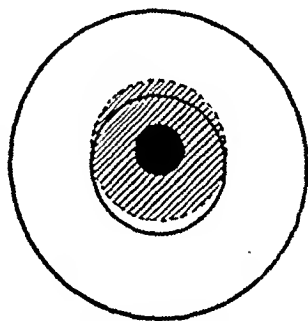


Fig. 1.—Dropping of the corneal portion of a contact lens down over the cornea.

another. These differences in curvature consist mostly of short vertical radii and long horizontal radii.

Large differences in curvature are easily observed by the dropping or lateral displacement of the corneal section of the contact lens in relation to the cornea. This brings one back to pressure at the limbus, for the dropping corneal section pulls the limbus of the contact lens down on the limbus or onto the cornea itself.

Amazing amounts of scleral irregularity, however, are tolerated by patients having no pressure from the contact lens at the limbus. The irregularity is at odd points about the sclera and is not symmetrical on either side of the vertical diameter. Many slight areas of pressure are seen at the approximate insertion of the rectus muscles. If they are of sufficient magnitude to cause pressure at the limbus, they will not be tolerated.

One woman requesting a fitting of contact lenses showed a gross irregularity in the left eye and a decided but much less extensive irregularity in the right eye. As it was certain that the lens for the left eye

had to be molded in order to obtain a satisfactory fitting, the patient was advised to have lenses for both eyes molded at once. She felt, however, that satisfactory vision could be obtained with one lens only, as her refraction was — 23 D. in each eye, and asked for a fitting of the right eye with the best trial lens. The fluorescein test showed considerable irregularity. The cornea was small, and no pressure was discernible at the limbus. Therefore, a trial lens was fitted for a tolerance test. Contrary to expectation, this lens was worn for over four hours with no discomfort. Because of this, a spherical lens ground to her prescription was ordered. The finished lens was worn with as much comfort as the trial lens.

In a paper on the use of contact lenses in cases of ametropia,¹ a frankly experimental technic for making casts of the human eye was suggested. The general principles involved remain somewhat the same. Numerous details are entirely different and much more satisfactory as revised. Since several papers^{1a} have appeared giving two entirely different types of technic, it is hoped that a critical description and comparison of the three methods in use will serve to stimulate an interest for further research in molding processes.

Two investigators² have reported the use of a wax shell inserted under the lids, in much the same manner as a Müller contact lens, and left in position on the eye for ten or more minutes. The patient is instructed to move his eyes about in a normal manner, so that the wax, softening at body temperature, will take on the approximate shape of the globe influenced by the muscular play as exerted in natural movements of the eye. A glass lens is placed in the corneal section in one method. When the wax shell is judged to have assumed the natural shape of the eye being molded, ice water is poured over it to harden it sufficiently to resist a change in shape as it is being removed. A rubber sucker, such as is used for inserting and removing Zeiss contact lenses, is used to remove the shell.

The possibilities for error with this method seem obvious. The wax shell primarily will not give a detailed mold of the eye. The most that can be expected is that the general shape of the eye, limited to the high points, will be faithfully recorded. It has been claimed that details of any depressions are not desirable; whether this is so cannot be definitely stated at this time. Ice water poured over an eye will certainly cause a severe involuntary contraction of the muscles of the lids, even

1. Obrig, T. E.: Fitting of Contact Lenses for Persons with Ametropia, *Arch. Ophth.* **17**:1089 (June) 1937.

1a. Bruce, G. M.: Contact Glasses, *Am. J. Ophth.* **20**:605 (June) 1937.

2. Feinbloom, W.: A Plastic Contact Lens, *Am. J. Optom.* **14**:41, 1937.
Prister, B.: I vetri adesivi ed il calco del segmento anteriore del bulbo, *Boll. d'ocul.* **12**:149, 1933.

though the conjunctiva has been thoroughly anesthetized. A distortion of the wax shell may result.

If the shell has been removed without distortion, it must then be placed in ice water, where it is constantly subject to distortion, before a casting can be made from it.

Although no change in shape may have occurred before the positive cast is made, this process, governed to some extent by the physical and chemical characteristics of the casting material, is a further possible source of distortion.

The method for molding used at the Institute of Ophthalmology of the Presbyterian Hospital in New York was devised to obtain records of the corneas in cases of keratoconus and is efficient for that purpose.³ No record of the scleral curvature was desired or attempted.

The procedure calls for the use of a speculum to hold the lids apart. An aluminum dam open at both ends is placed in contact with the sclera so that it surrounds the cornea. Liquid negocoll is poured into it and allowed to gel. The dam and negocoll together are then removed from the eye, and a positive plaster cast is made from the negative so formed.

The criticism of this method of molding for contact lenses is that there is a possibility of a distortion of the scleral surface due to pressure brought to bear by the narrow bearing surface of the circumference of the aluminum dam. Further, there is a lack of opportunity to obtain sufficient scleral surface to be of use in molding contact lenses. The speculum prevents large enough dams to be used to obtain a wide scleral band about the limbus.

The method now used is directly a result of independent investigation and experiment by Dr. D. B. Kirby and myself, except for employment of a molding shell with a handle. The evolution of this device will be given later. This method of making molds of the living eye has several important advantages. First, considerable scleral surface can be molded about the cornea. The limit of the area obtained is governed by the size of the palpebral opening, the looseness of the lids, the size of the globe and the position of the eye in the orbit.

Various-sized shells may be employed, and contact lenses of varying sizes may be made from the molds obtained. It is obvious that an eye with a small palpebral opening and a deep-set globe will not require as large a finished lens as an eye which shows a moderate degree of exophthalmos. The size of the molding shell which may be used successfully will mold sufficient scleral area to produce a finished molded lens of proper dimensions for each patient.

3. Stevens, C. L.: Method for Making Casts of the Human Cornea, *Am. J. Ophth.* **19**:593 (July) 1936.

Second, pressure on the globe is distributed evenly over a large area, with little, if any, pressure on the sclera from the rim of the molding shell. This condition minimizes distortion of the sclera by the casting shell itself. Corneal distortion does occur at times because of the more resilient quality of the corneal tissue. Such an irregularity, which is mostly confined to the apex of the cornea, is of no importance, because with the new technic the corneal section of the cast is not used. The scleral curvature and the outline of the limbus are the details desired from the casting.

Third, extremely fine detail results with the negocoll and casting shell procedure. Every scleral irregularity is truly reproduced in the finished casting.

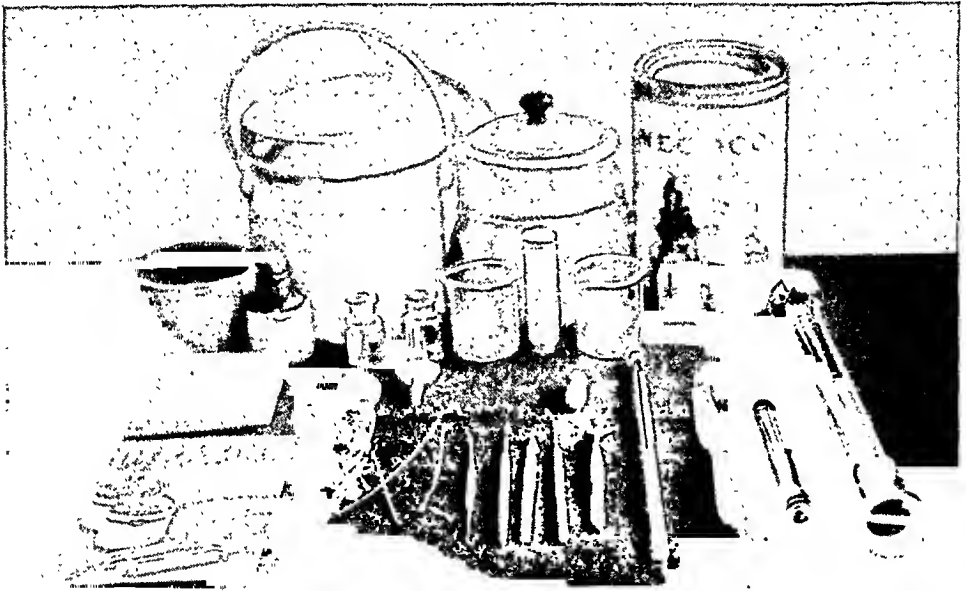


Fig. 2.—Equipment for making castings.

Fourth, the negocoll mold, being backed up by the rigid glass casting shell, prevents any chance of distortion of the mold before the cast is poured.

Fifth, the time factor is important. With proper preparation, the physician need spend little time with the patient. The whole procedure need not take more than fifteen or twenty minutes.

EQUIPMENT NEEDED

The equipment necessary for making a finished cast consists of:

1. A set of Zeiss afocal trial contact lenses
2. Poller's negocoll
3. A double boiler

4. An electric or gas stove or a sterilizer
5. Two 50 cc. pyrex beakers
6. One 250 cc. beaker
7. An Eastman kodak stirring thermometer
8. Molding shells of various sizes
9. A stainless steel spatula
10. Demitasse spoon
11. Cotton
12. Gauze pads
13. Absorbent tissue
14. Cotton-tipped toothpicks
15. A modern local anesthetic
16. Epinephrine hydrochloride
17. Several small narrow-mouthed bottles
18. A small plaster bowl
19. French's regular dental plaster or albastone
20. Half-normal solution of sodium chloride or Ringer's solution
21. Undine or syringe for washing out eyes
22. A muscle hook

THE MOLDING SHELL

The first castings were made with the aid of Müller lenses, the technic being that of Dr. D. B. Kirby, as reported in the *ARCHIVES OF OPHTHALMOLOGY*.¹ Shortly after this procedure was successfully used, it was brought to the attention of Dr. Harry Eggers. He suggested that a Müller lens with some sort of a handle would be a distinct advantage over the ordinary Müller lens. With this thought in mind, I began experimenting with various designs of casting shells, with the assistance of Mager and Gougelman, manufacturers of glass eyes. One of these shells was described in the aforementioned report, in which the technic employing the Müller lens-molding shell was given. This shell, while being an advance, had several disadvantages.

The present solution of the problem of the casting shell consists of making the shells oval and 22 by 24 mm., 23 by 25 mm. and 24 by 26 mm. in size (fig. 3). The long sides are arched in much the same manner as an eye cup. The depth of the shell from the lowest portion of this arch to the integral hollow handle is about 7 mm. The handle is 25 mm. long, hollow and tapering slightly to a sealed far end. One of the long ends of the shell is marked with a red line to indicate the position of the right nasal side (red for right), and any other colored line is used for the shell applied to the left eye. These shells give sufficient scleral coverage and are easily inserted beneath the lids. The nasal markings are simple to place in the proper position. They are comparatively easy to remove intact with the negative negocoll mold.

NEGOCOLL AND ITS PREPARATION

Poller's negocoll has proved satisfactory in use. The number of my moldings amounts to well over 400. In no case has any injury or destruction of corneal epithelium taken place, except to the most negligible extent, and that did not cause the patient any distress or discomfort.

The manufacturers suggest that negocoll be prepared in nickel or enamelware utensils and not in aluminum, which metal has an undesirable effect on the negocoll, reducing materially the number of times it may be used. It seems unwise to use enamelware for ocular work because of the possibility of chipping and of resulting corneal injury should a chip be included in the negocoll placed on the eye. Nickel utensils are difficult to obtain, and the solution of this problem may be the use of pyrex glass or porcelain. Regardless of the manufacturer's caution, I have used an aluminum double boiler in all my work.

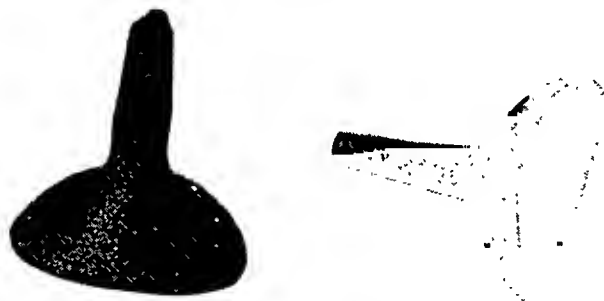


Fig. 3.—Molding shells.

To prepare negocoll for use, several ounces of the material is placed in the upper part of a double boiler, together with as much warm water as it will absorb. Any surplus water is poured off, and the wet mass is boiled until it becomes a homogeneous semiliquid. Prolonged boiling does not seem to affect its gelling qualities; it tends rather to produce a more even, lumpless mixture. A lid should be kept on the boiler to prevent undue evaporation of the water content. The exact consistency best adapted to the individual physician can be determined best by experiment. Generally, it may be stated that the thicker the mixture the quicker the gelling and the higher the temperature at which it will gel. However, no matter how liquid it may be at temperatures over 100 F., it will always gel at body temperature. When the mixture is at 150 F., it should be as liquid as a heavy cream for best results. As it is cooled, a thickening will take place, until at 104 F. it may best be described as of the consistency of warm molasses. In mold-

ing, a small portion of the negocoll should be transferred to a 50 cc. beaker for cooling and the main portion kept hot.

DETAILED PROCEDURE FOR FITTING MOLDED LENSES

The patient is fitted with the best fitting afocal trial contact lens. Care must be taken to clear the cornea with the corneal portion of the lens and to see that there is as little pressure at the limbus as possible. The least pressure at the limbus can be assured by fitting a trial lens which is slightly tight at the scleral rim. Such a lens, besides clearing the limbus, will be most easily removed. The fit of the scleral portion is not important, as the cast will take the place of this measurement when the finished lens is ordered.

With the chosen contact lenses in place, refraction is done with care. Only spherical corrections can be ground on the contact lens, and therefore the best spherical correction used in conjunction with the trial contact lens is recorded. Any manifest astigmatism is lenticular and cannot be corrected. It is usual to find from plus or minus 0.25 D. to plus or minus 1.25 D. of lenticular astigmatism in about 5 per cent of the patients fitted.

The vertex distance of the refracting lenses, that is, the distance between the posterior surface of the refracting lens and the anterior surface of the contact lens, must be carefully measured and noted on the prescription.

The corneal curves of the contact lenses are recorded also, and the complete prescription will read something like:

O.D. —7.00 D. at 10 mm. V.D. with 8 mm. corneal curve

O.S. —6.00 D. at 10 mm. V.D. with 8 mm. corneal curve

As soon as the data concerned with the refraction are recorded, the contact lenses are removed, and the patient is prepared for the molding.

PREPARATION OF PATIENT FOR MOLDING

For a rapid successful molding, the patient should be prepared both mentally and physically to insure his active cooperation.

In order to still his imagination, the entire procedure should be described to him in a few words. As trial lenses have already been applied and because that procedure is always much less distressing than the patient imagines, he should be told that the taking of a mold is no more disagreeable than the insertion of a contact lens.

It should be forcefully stated that the successful completion of the molding depends on his cooperation, principally in three ways: First, he must keep the eye not worked on open and gazing at a point predetermined to center the cornea properly. Second, he must keep his eyes quiet and fixed on this point for the first two minutes at least.

Lastly, he must move his eyes as directed while the mold is being removed and not become anxious if considerable time is taken in doing so. In 1 unusual case nine minutes was required to remove the casting shell with the negocoll mold intact. On the average, this procedure requires only two or three minutes.

The patient should have a thorough conjunctival anesthetization with any of the modern local anesthetics. With the last drop, just before the molding shell is placed on the eye, 1 drop of epinephrine hydrochloride will help to prevent undue congestion.

CONSTRUCTION OF THE MOLD

The patient is placed on his back and made comfortable. A careful check of the position of the eyes must be made at this time. A slightly upward positioning of the cornea is to be preferred. An additional drop of anesthetic and a drop of epinephrine hydrochloride are given to insure a painless molding, free from congestion.

The nurse should have prepared the negocoll, as previously described, while refraction was being done. From the double boiler, she now places about 20 cc. of the hot negocoll in a 50 cc. pyrex beaker, stirring it gently with a stirring thermometer, with which the temperature of the mixture is carefully watched. A beating motion should not be used, as this will separate the cotton fiber contained in the negocoll in such a way that it will collect about the shaft of the thermometer.

A piece of absorbent cotton is firmly forced into the hollow handle of the molding shell and slightly tufted out at the top. This is done to help bind the negocoll mold to the casting shell and prevent the separation of the two when they are being removed from the eye.

When the negocoll cools to 105 or 104 F., the physician completely fills a molding shell from the beaker with a spatula or a demitasse spoon or by pouring directly from the beaker. The shell is held hollow side up until it is over the patient's eye. The upper lid is pulled well back; the shell is inverted and, with the nasal marking placed toward the nose, is inserted under the lid. An assistant immediately retracts the lower lid, and the shell and negocoll are lowered onto the globe with as little vertical or horizontal movement as possible, to prevent conjunctival folds.

Considerable negocoll will have been forced from under the shell over the eyelids. No attempt should be made to wipe this excess away. The negocoll should be allowed to gel in position, as it will help to keep the eye centered by binding the lids to the shell. It is easily removed with a muscle hook when solid.

During the foregoing procedure it is absolutely necessary that the patient keep the eye not worked on open and fixed on the ceiling

marker. Dr. Kirby suggested that in cases of aphakia or of high myopia the patient's prescription lenses may be held over the open eye to assist him. If the eye not worked on is closed, both eyes have a tendency to roll upward. This results in an upward displacement of the corneal position in the finished mold. If necessary, the upper eyelid can be held open to prevent closing for the first two minutes the casting shell is on the other eye.

The negocoll and shell are left untouched for a five minute setting period, after which the excess negocoll is easily loosened from the margins of the lids with a muscle hook. The patient is then instructed to look down, and the upper lid is retracted so that the upper edges of the negocoll mold may be seen. If this extends upward to some extent beyond the molding shell, it is carefully loosened with the aid of a muscle hook as the casting shell is gently pressed downward by the handle, with one finger of the hand holding up the lid. The patient is then instructed to look up, and the lower margin of the negocoll mold

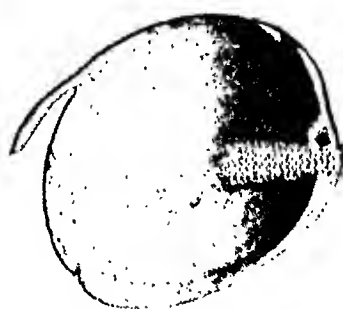


Fig. 4.—Negative negocoll mold.

is loosened in the same manner. The nasal and temporal portions are inspected next. Finally, the entire casting shell is given alternate vertical and horizontal movements to break up the adhesion over the cornea, where considerable suction often tends to hold the mold to the eye. If any difficulty is experienced in breaking this suction, the rounded edge of a muscle hook can be carefully placed under the shell at the nasal or temporal end, and with gentle upward pressure the entire shell and negocoll can be raised slightly to let in some air. Once air enters beneath the mold, it will come away easily. If the greater part of the overflow of negocoll is beneath the lower lid, the shell is removed with the upper lid retracted. If the greater mass is under the upper lid, the lower lid is retracted when the mold is removed.

If an unsatisfactory centering of the corneal portion results, a mold should be made of the other eye, and when this is completed a second mold should be made of the first eye. Several patients have had three moldings of each eye during the same afternoon, with no ill effects. One should be guided by the amount of visible inflammation, however, in each individual case.

Any visible chemosis is a contraindication to further molding, as it is impossible to obtain the true scleral curvature when any edema is present. The ideal mold will produce slightly more scleral area below the cornea than above it.

As soon as satisfactory molds are made, the patient's eyes should be well examined for loose pieces of negocoll. These are particularly likely to remain under the upper lid, high up, and often extend horizontally entirely across the fornix.

Immediately on removal, the mold should be placed in cold water while a mold of the second eye is being made. After the second mold is well chilled, all excess water is shaken from the mold and the surface partially dried with a cotton ball. The molding shells are then placed handle down in a pair of small narrow-mouthed bottles. French's regular dental plaster or some good dental stone is prepared in a small



Fig. 5.—Shell with negocoll mold and plaster cast in bottle.

soft rubber plaster bowl and well spatulated to remove bubbles. The bowl is pinched to form a spout, and the plaster is poured into the molds from one side while liquid to prevent the formation of air pockets. One should not wait for the plaster to thicken before pouring it.

The mold and cast should not be touched for half an hour. At the end of that time a line should be drawn across the cast from the inner to the outer canthus. With the shell held as it would be if removed from one's own eye, L or R is marked above the horizontal line to indicate whether the cast is for the right or the left eye; then an N is marked to the nasal side and a T to the temporal side of the R or L. Under the horizontal line, the patient's name is engraved. The markings then appear thus:

$$\begin{array}{c} \text{N R T} \\ \hline \text{Jones} \end{array}$$

After the castings are marked, they are left to harden for another hour. At the end of this time the cast and negocoll are removed together from the casting shell. A small knife is run about the edge of the shell to cut away any plaster which has run over the sides.

A small spoon spatula, such as is used for removing wax from the ear, is worked between the negocoll and the plaster cast at the nasal or temporal side and then gently run about the entire circumference of the casting to loosen the negocoll from it. As soon as the edges are free, the negocoll and the casting separate easily. If the cast and negocoll have been left standing so long that difficulty is experienced in separating them, they should be soaked in warm water for half an hour.



Fig. 6.—Cast showing markings on the back.



Fig. 7.—Three plaster casts of eyes.

A second casting should be retained by the ophthalmologist for checking or for use in case any accident may happen to the casting supplied the Zeiss Company. While it is possible to make a second casting from the original mold if it has been removed carefully, after it has stood in cool water for a while the accuracy of the second cast is open to question. Some drying of the original negocoll mold will have taken place, and the soaking in cool water will replace this loss. However, to what extent this takes place has not been determined.

With no special preparation, 40 patients have been fitted with molded contact lenses in one visit. The entire procedure was completed in from one to one and a half hours. In these cases I inserted

the trial contact lenses, prepared the negocoll and did the actual molding and the pouring of the casts. The physician made a general preliminary examination, refracted the eyes with the trial lenses in place, checked the corneal clearance with a slit lamp and assisted in the inserting and removing of the molding shells.

In view of the time taken in fitting ground contact lenses, which often requires from six to ten visits, it is evident that much time and effort can be saved by prescribing molded contact lenses. There are times when a satisfactory mold is not obtained during the first visit, and in these instances the patient must return for a remolding. Experience has taught that with adequate cooperation from the patient such cases decrease in number as one becomes familiar with the process of molding.

THE FINISHED LENSES

The finished lenses, as supplied by Carl Zeiss, are oval and of the general dimensions called for when ordered. The anterior surface of

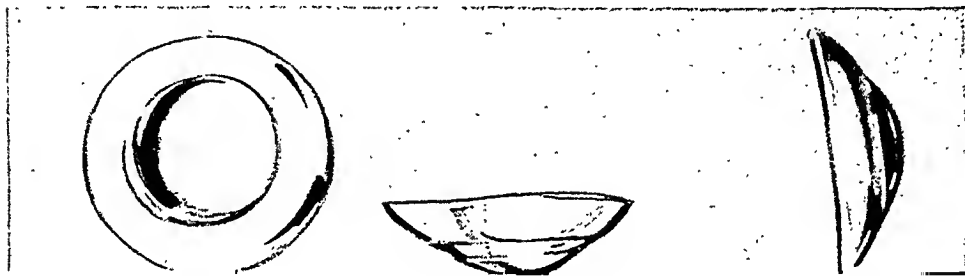


Fig. 8.—Finished molded contact lenses.

the scleral portion appears uneven, with much the same appearance as the scleral portion of the cast. This unevenness in surface tends to make the finished lens better tolerated, as it fits in what may be called "spot contact" on the sclera instead of over a continual even surface, as is seen with the ground lens. This is an advantage in that the blood supply of the anterior fifth of the globe is less disturbed and the nutrition of the cornea, therefore, less affected. Further, the flow of the tears under the contact lens is facilitated, thus shortening the time necessary to replace the fluid used when inserting the lens. The accumulation of oil, principally from the upper lid, under the corneal portion of the contact lens is also minimized by the increased flow of lacrimal fluid under the lens.

The corneal portion of the molded lens is ground and polished to prescription with the care and accuracy expected for an ophthalmic lens of first quality. In fact, the corneal portion is identical to that

supplied in the ground type of contact lens, with which ophthalmologists have been familiar for a number of years.

In all molded lenses recently received, allowance for the width of the patient's cornea has been made by molding a third curve nasally and temporally adjacent to the corneal portion proper. This type of grinding has proved to be the solution of the problem of the wide cornea.

The science of haptics,⁴ which has to do generally with touch, and in regard to contact lenses with the bearing of the surface of the con-

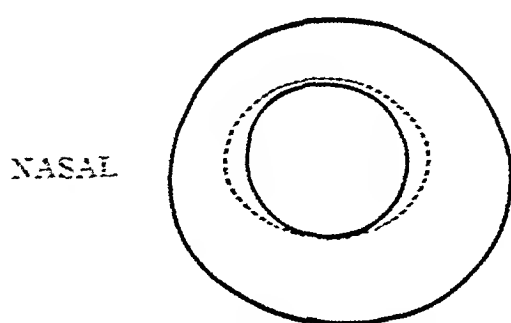


Fig. 9.—Ideal position for the corneal portion of a contact lens.

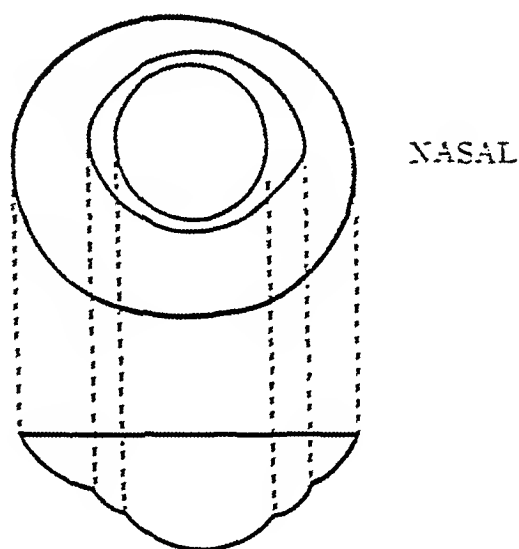


Fig. 10.—Molded contact lens with molded area about the ground corneal portion to take care of a wide cornea.

tact lens against the conjunctiva, is used in a most delicate manner in altering to some extent the actual scleral surface supplied by the casting before a contact lens is molded from it. Experience with contact lenses forces one to realize that the fit of any contact lens should be slightly loose, principally near the insertion of the rectus muscles. When one

4. Thier, P. F. X.: Haptik von Kontaktgläsern, *Klin. Monatsbl. f. Augenh.* 96:542 (April) 1936.

is fitting the ordinary ground Zeiss contact lens, the tightness caused by muscular movement is easily observed over the relaxed muscle rather than over the active muscle during ocular movements; with a well fitted scleral portion on the eye, when the eye is moved temporally a tightness is seen near the insertion of the internal rectus muscle. When the eye is rotated slowly nasalward, this tension is observed to decrease gradually until it is no longer present. This same type of tightness is often seen templeward, when the eye is moved nasally. On eyes with practically spherical scleras, tightness is often observed near the inferior rectus muscle as the eye is moved upward. However, the horizontal movement seems to be the principal cause for concern.

Care must always be taken that the lower scleral flange of the contact lens is not loose enough to extend away from the sclera, because the lower lid is likely to catch under it and force the lens from the eye, or in any case to prevent the lower lid from sliding up over the contact lens. If it is desirable to make the lower flange of the lens fit loosely for any reason, it should be made deep enough to avoid any possible contact with the margin of the lower lid.

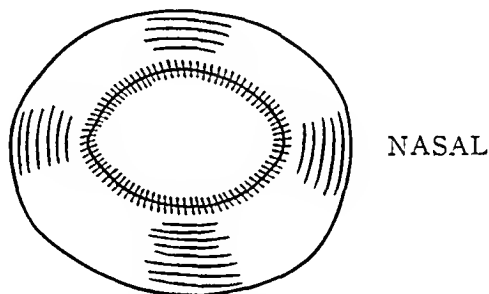


Fig. 11.—Mold demonstrating the need of building up to clear the limbus and allow for muscular play. The shaded areas indicate the portions to be built up.

The upper portion of the scleral band of the contact lens presents the least difficulty. It does not seem to need as much bearing surface as the three other portions. It presents little, if any, indication of tightness when the eyes are directed downward if the scleral portion is well fitted.

In view of the foregoing observations, it seems logical that a satisfactory fit of the scleral portion will result in a molded contact lens if the bearing surface is slightly tighter at the four points formed by two crossed lines at 45 and 135 degrees to the horizontal, favored nasally above and templeward below to neutralize the slight torque caused by the movement of the lids.

The only requirement of the corneal portion besides giving adequate vision is a positive clearance of the limbus. Carl Zeiss has apparently solved the problem of pressure at the limbus in the molded lens by the extra horizontal molding at the nasal and temporal sides of the corneal

section, which can be obtained by building up on the original cast for a distance of 1 mm. inside and outside of the sulcus.

INSTRUCTIONS FOR ORDERING LENSES

When the finished lenses are ordered, the casts are sent to provide the scleral curvature and the size of the corneas.

The refraction with the trial lenses in place gives the information necessary to grind the corneal portion of each lens. Three elements must be stated here: the corneal curve of the contact lens used, the added correction necessary and the vertex distance of the refracting lens from the corneal portion of the contact lens.

The size of the lens required must be stated and may be varied to meet individual needs: 20 by 21 mm. for eyes of average size; 19 by 20 mm. for small eyes, and 21 by 22 or 22 by 23 mm. for large protruding eyes.

An example of an adequate order, with instructions for marking the lenses and the casts, follows:

One pair of molded contact lenses as prescribed from the casts supplied. Lenses to be made 20 by 21 mm.

O.D. —7.00 at 10 mm. V.D. with an 8 mm. corneal curve

O.S. —6.00 at 10 mm. V.D. with an 8 mm. corneal curve

Mark lenses with an engraved line at the nasal sides and the left lens with an L.
Casts marked:

T L N
Jones

N R T
Jones

FITTING THE FINISHED LENSES ⁵

Before the finished contact lenses are delivered to the patient, he must be taught to insert them and remove them with ease. A satisfactory solution must also be prescribed for use with the lenses. Transient corneal opacities and clouding of the corneal liquid lens formed between the contact lens and the cornea, with the resulting rainbow colors often complained of, have proved difficult to overcome.

A study of the causes of these difficulties has made it possible to minimize their effect to a negligible amount. The chemical composition, density, p_H and refractive index of the solution are all concerned.

A solution with chemical and physical characteristics similar to each individual lacrimal fluid will not cause opacities. Physiologic solution of sodium chloride is the least satisfactory of those tried and should not be used.

Clouding of the fluid lens over the cornea is due primarily to a collection of the oily secretion from the sebaceous glands of the lids.

5. Obrig, T. E.: Recent Advances in the Technic of Fitting Contact Lenses. *Guildcraft* 11:33, 1937.

To a lesser degree, clouding is due to mucus in solution or in strands which work their way under the corneal portion of the contact lens.

Dr. Kirby has suggested that clouding can be minimized by instructing the patient to massage the lids at the lashes, using a piece of gauze or linen over the index finger. With a horizontal movement above and over the lashes, the sebaceous material is expressed from the glands. This procedure is followed with a thorough washing of the eyes, an eye cup being used, to remove the expressed oil and any mucus present. The solution used with the contact lens to form the liquid lens can be employed satisfactorily for this purpose.

After considerable experimenting and the trial of a number of solutions, the most satisfactory one has been found to be a sodium borate-boric acid buffer solution, as suggested by Feldman,⁶ made to the approximate p_H of the patient's lacrimal fluid as found mixed with the normal mucus on the lower eyelids.

A satisfactory determination of the approximate p_H can be obtained with nitrazine paper rubbed on the lower lids near the inner canthi. This test paper changes color and is compared with a color chart supplied. Estimates between the p_H color changes indicated may easily be made. If the test paper turns bluer than the chart color which indicates p_H 7 and still not dark enough to match that for p_H 7.5, an estimate of p_H 7.2 may be made. A color darker than that which indicates p_H 7.5 may be estimated as p_H 7.8.

To prepare the buffer solution in varying p_H intervals, two parent solutions are prepared according to the following formulas and combined as indicated. The refractive index of these solutions is approximately 1.335, which is satisfactory.

Solution 1

Sodium borate	19.108 Gm.
Distilled water	1,000.000 cc.

Solution 2

Boric acid	12.404 Gm.
Sodium chloride	2.925 Gm.
Distilled water	1,000.000 cc.

To obtain the various p_H values, the two solutions are mixed in the following proportions:

p_H	Sodium Borate, Cc.	Boric Acid Solution, Cc.
7.0	0.95	9.05
7.2	1.0	8.5
7.5	1.5	8.0
7.8	2.0	7.5
8.0	2.6	6.9

6. Feldman, J. B.: p_H and Buffers in Relation to Ophthalmology. Arch. Ophth. 17:797 (May) 1937.

INSTRUCTIONS TO PATIENT

The patient will be able to insert and remove the contact lenses easily if the following instructions are given.

Insertion.—Massage the eyelids at the eyelashes with a piece of gauze to remove oil from the glands on the lids. Use horizontal movement.

Wash the eyes with an eye wash to remove all oil.

Warm the solution used with the contact lens.

Place the contact lens, well centered, on a rubber sucker.

Fill the contact lens with the warm solution.

Raise the upper lid with the fingers over the lashes.

Keep the eye fixed on the hole in the sucker, and place the lens against the eyeball and over the lower lid.

Release the upper lid.

Keep firm gentle pressure against the eye.

Push the lens upward slightly toward the eyebrow and at the same time pull the lower lid well down.

The glass will then jump over the margin of the lower lid onto the eyeball.

Release the lower eyelid.

Press on the sucker to remove suction, and remove the sucker sideways.

Wipe excess liquid from the lids.

Removal.—Separate the eyelids with the fingers over the lashes.

Look directly at the hole in the sucker.

Press the sucker bulb.

Place the sucker firmly against the center of the contact lens.

Release the sucker bulb to obtain suction.

Pull the lens down and out from the eye.

Do not move the eyes around. Keep the vision fixed on the hole in the sucker when inserting and removing contact lenses.

FURTHER PROBLEMS

Two important problems requiring careful investigation and research must still be solved in order to obtain maximum comfort with the satisfactory contact lenses available today. First, a better buffer solution, more nearly identical with the lacrimal fluid and still flexible enough to be prepared in varying p_{H} intervals, is essential. Second, some form of treatment must be devised to toughen sensitive conjunctivas which will not tolerate contact lenses no matter how good the fit. This seems to call for a properly buffered astringent combined with a suitable anesthetic stable in an alkaline solution to enable the patient to bear the irritation of the astringent, which can be built up in strength as it becomes tolerated.

It is my sincere hope that the detail presented here will be of assistance to all those desiring to work with contact lenses, and still more important, that it will be a stimulus to further investigation, resulting in refinements and better methods of obtaining molds of the living eye. Any suggestions will be appreciated.

REPORT OF CASES

Case 22.—Mr. B. S. on refraction showed vision of 15/30 in the right eye with a -8.00 D. sph. $\ominus +9.50$ D. cyl., axis 125 (without lenses, 15/100) and of 15/30 in the left eye with a -8.50 D. sph. $\ominus +9.50$ D. cyl., axis 65 (without lenses, 15/100). He was fitted with Zeiss ground trial contact lenses, a lens 12.5/7.5, with -1.25 D. added power, being used in the right eye and one 12.5/7.5 being used in the left eye. Vision in the right eye was 20/20, and although that in the left eye was not recorded it was not as good.

The trial lens showed a decided irregularity in the scleral portion, with tightness horizontally and a dropping of the corneal portion of the contact lens. The limbus of the corneal portion of the trial lens also seemed to fall inside the limbus of the cornea. This fact was verified by the corneal size as measured from the casting, which was 12 by 14.5 mm.

A mold was made at once of the right eye alone, because the patient wanted only one contact lens. The casting was sent to Carl Zeiss, with instructions to make the lens 20 by 21 mm.

The finished lens was received in three months. The fit of the scleral portion was excellent, and the visual acuity was 20/15. The patient was taught to insert and remove the lenses in one-half hour.

The p_H of the patient's lacrimal fluid as determined with nitrazine paper was 7.8. A boric acid-sodium borate buffer solution of this value was prescribed.

At the end of one week the patient reported that he had worn the lens two and a half, three, four, five, six and nine hours on succeeding days. He stated that the eye was sore the first few days but that the irritation gradually decreased each day.

Two weeks later the patient reported that the lens was satisfactory and had been worn from three to seven hours each day during the past two weeks.

CASE 1.—Miss V. B. on refraction showed vision in the right eye of 20/30 with a $+8.50$ D. sph. and in the left eye of 20/20 with a $+8.00$ D. sph. She was fitted with Zeiss ground trial contact lenses, a lens 12.5/7.5, with $+1.75$ D. added power, being used in the right eye and one 12.75/7.5, with $+1.50$ D. added power, being used in the left eye. Vision in the right eye was 20/30 and in the left eye, 20/20.

The right trial lens showed a decided tightness horizontally combined with a looseness vertically, with a dropping down of the corneal section of the contact lens.

The left trial lens was a fair fit but looked small on the eye and had a tendency to catch on the lower lid. The eyes appeared larger and more protruding than the average, and the palpebral openings appeared wider. Careful measurement of the corneas with a ruler gave a horizontal width of 13 mm., which on the basis of my experience with castings was considered 20 per cent under actual measurements. This fact was verified later by the castings made, on which the corneas were measured as 13.5 by 15 mm.

In view of the irregular scleral curve of the right eye, the position of the eye in the orbit, the large palpebral opening and the large cornea, molds of each eye were made. Satisfactory casts were obtained with the first molding, and these were sent to Carl Zeiss, with instructions to make the lenses 22 by 24 mm. in size.

The finished lenses were received in four months and proved to fit perfectly in the scleral portion.

The vision obtained was also satisfactory, showing on test 20/30 in the right eye and 20/20 in the left eye, as with the trial lenses. The lenses were worn for two hours, with no irritation at this time.

The p_H of the patient's lacrimal fluid as determined with nitrazine paper was p_H 7.5. A sodium borate-boric acid buffer solution of this value was prescribed.

At the end of one week the patient reported that the contact lenses had been worn for several hours each day, but that she had cracked the right lens cleaning it and was no longer able to try to establish a tolerance. A new lens was ordered to replace the cracked one.

CASE 3.—Miss M. B. on refraction showed vision of 20/40 in the right eye with a -5.00 D. sph. and of 20/20 in the left eye with a -5.50 D. sph. She was fitted with Zeiss ground trial contact lenses, a lens 12/8, with -3.25 D. added power at 12.5 mm. vertex distance, being used in the right eye and one 12/8, with -3.25 D. added power at 12.5 mm. vertex distance, being used in the left eye. Vision in both eyes was 20/30 +.

Each trial lens showed an irregularity in the scleral portion, with tightness horizontally combined with a looseness vertically. The corneas as measured with a ruler were a short 12 mm. The castings proved the corneal measurements to be 11.5 by 13 mm. in the right eye and 12 by 14 mm. in the left eye.

Moldings were made at once and proved satisfactory on the first trial. The plaster casts were sent to Carl Zeiss, with instructions to make the lenses 20 by 21 mm.

The finished lenses were delivered in four months. The fit of the scleral portion was perfect, and the visual acuity was 20/20 in each eye and 20/15 with both eyes. The patient wore the lenses for three hours at this time and reported that they felt better before removal than when they were originally put on.

The p_H of the patient's lacrimal fluid as determined with nitrazine paper was about 7.6. A sodium borate-boric acid buffer solution with p_H 7.5 was prescribed.

At the end of one week the patient reported that she had worn the lenses for three hours every day and had no opportunity to wear them longer at this time. A slight smarting was noticed the first two days but was not felt after this time. No irritation was present when the lenses were removed.

At the end of the second week the patient reported that the lenses were worn with comfort for from three and a half to four hours at a time and by the end of the week for two four hour periods a day. No irritation was present when they were removed. The only trouble experienced was some clouding after four hours of wearing. This was due to dissolved mucus and sebaceous material and not to any clouding of the cornea, as vision was clear immediately on the removal of the contact lenses.

At the end of a month and a half the patient reported that the lenses were well tolerated and said: "They seem to fit beautifully and I am very pleased with them."

CASE 10.—Mrs. E. H. on refraction showed vision of 20/25 in the right eye (aphakia) with a $+12.00$ D. sph. and of 20/20 in the left eye with a plano lens. The right eye was fitted with a Zeiss ground trial contact lens 12.75/7, with $+9$ D. added power at 10 mm. vertex distance, vision being 20/20.

The trial lens showed a decided irregularity in the scleral portion, with tightness horizontally, and a satisfactory mold was made at once.

The corneal measurement from the cast was 12 by 13 mm.

The casting was sent to Carl Zeiss, with instructions to make the lens 20 by 21 mm. in size.

The finished lens was returned in five months and presented a satisfactory fit in the scleral portion, with vision of 20/30 +.

The p_H of the lacrimal fluid as determined with nitrazine paper was 7.5, and a sodium borate-boric acid buffer solution of this value was prescribed.

It had been thought that with the ametropia corrected by a contact lens, the aniseikonia induced by monocular aphakia might be corrected more easily with isekonic lenses. This, however, does not seem probable.

CASE 19.—Miss E. P. on refraction showed vision of 20/20 in the right eye with a -5.00 D. sph. and of 20/20 in the left eye with a -5.00 D. sph. She was fitted with Zeiss trial contact lenses, a lens 12.5/8, with -5.00 D. sph. added power at 13 mm. vertex distance, being used in the right eye and one 12.75/8, with -5.00 D. sph. added power at 13 mm. vertex distance, being used in the left eye. Vision was 20/15 in each eye.

The trial lens for the right eye showed a slight irregularity of the scleral portion, with looseness temporally. That for the left eye showed a decided irregularity of the sclera portion, with tightness vertically. The corneas seemed larger than the corneal portions of the contact lenses.

Molds were successfully made during the second visit and were sent to Carl Zeiss, with instructions to make the lenses 20 by 21 mm. The sizes of the corneas as measured from the casts were 12 by 13.5 mm. for the right eye and 12 by 13.75 mm. for the left eye.

The finished lenses were received in four months and showed an excellent fit in the scleral portion, with vision of 20/15 in each eye. The lenses were worn for two hours the day they were received.

The p_H of the patient's lacrimal fluid as determined with nitrazine paper was 7.5. A sodium borate-boric acid buffer solution of this value was prescribed.

At the end of a week the patient reported that the lenses were worn from one half to three quarters of an hour several times during the week and were not used every day. The right lens felt much better than the left one each time they were worn.

At the end of the second week she reported that the lenses were worn only three quarters of an hour each evening. The right lens gave no trouble, but the left caused a burning sensation at the end of this time.

The patient was asked to call for observation. The fit of the scleral portion was excellent, but on retaking the p_H of the lacrimal fluid a reading of p_H 7.8 was obtained instead of p_H 7.5 as previously determined. A new prescription for a sodium borate-boric acid buffer of this strength was given. As a further experiment, a prescription for a sodium carbonate-boric acid buffer (Gifford) p_H 7.8 was given. At the end of another week the patient reported that both 7.8 buffers were decidedly better than the first solution prescribed and that she was able to wear the lenses from two to three hours. She felt much encouraged and promised to continue to establish a tolerance.

CASE 18.—Miss N. K. on refraction showed vision of 20/50 in the right eye with a -6.00 D. cyl., axis 20 and of 20/50 in the left eye with a $+1.50$ D. sph. $\ominus -6.00$ D. cyl., axis 150. She was fitted with Zeiss trial contact lenses, a lens 13/7.5, with -2.00 D. added power, being used in the right eye and one 13/7.5, with no added power, being used in the left eye. Vision was 20/40 in the right eye and 20/20 in the left eye.

The trial lenses showed the greatest irregularity of the sclera so far encountered, approximately 2 mm. difference in radius of curvature between the horizontal

7. Gifford, S. R.: Reaction of Buffer Solution and of Ophthalmic Drugs. Arch. Ophth. 13:78 (Jan.) 1935.

and the vertical radius. The vertical radius was the shorter, and the best fitting trial lenses were tight horizontally. The patient had a mild keratoconus and could not be given vision of over 20/50 with ordinary spectacle lenses.

Molds were immediately and satisfactorily made during the first visit, and the castings were sent to Carl Zeiss, with instructions to make the lenses 20 by 21 mm. The corneal measurements from the casts were 12 by 13 mm. for the right eye and 12 by 12.5 mm. for the left eye.

The finished lenses were received in four months. The great difference in the curvature of the two meridians was apparent in the lenses before they were placed on the eyes. A satisfactory fit of the scleral portion was obtained, and the visual acuity was the same as with the trial lenses. With a -1.50 D. cylinder before the right contact lens, the visual acuity was raised to 20/30 +, indicating a considerable amount of lenticular astigmatism. The patient wore the lenses for two hours the day they were delivered. A mild congestion was present when they were removed.

The p_H of the lacrimal fluid as determined with nitrazine paper was 7.5. A sodium borate-boric acid buffer solution of this value was prescribed.

At the end of three weeks the patient reported that she could not wear the lenses longer than two or three hours at a time. A new buffer solution, of p_H 7.8, was prescribed. She reported less smarting with this solution and is still trying to establish a tolerance.

CONCLUSIONS

The principal difficulty in securing comfort with contact lenses is due to pressure at the limbus, horizontally.

Corneal measurements are difficult to take from the eye itself.

Corneal measurements are most accurately and easily measured from a cast of the anterior portion of the eye.

Corneal measurements so taken are considerably larger than generally believed, averaging 12 by 13.5 mm.; 74 per cent of those measured are from 13 to 14 mm. horizontally; 65 per cent, from 12 to 12.5 mm. vertically. Ten corneas measured 15 mm. in width.

Irregularity of the scleral portion is the second most important difficulty in securing comfort with contact lenses.

Such an irregularity causes discomfort by pulling the contact lens against the limbus, thus resulting in pressure at the limbus.

Negocoll has proved a harmless, satisfactory substance with which to mold the eye.

A satisfactory molding shell has been developed in various sizes to meet individual requirements.

The molding process using negocoll and a special molding shell is the most satisfactory method of making a cast of the anterior portion of the eye.

This method has produced no corneal injuries in over 400 moldings.

Three molds have been made from an eye during the same afternoon, with no ill effects.

The entire procedure of fitting molded contact lenses has been done during one visit of an hour and a half with 40 patients.

The new molded lens made from a casting of the anterior portion of the eye is more satisfactory than a ground lens, because it is molded and ground to avoid pressure at the limbus as well as to give a good fit in the scleral portion.

Measurements of the curve of the sclera and the size of the cornea for molded lenses are obtained from the cast.

Instructions for grinding the corneal portion are obtained by a visual manifest with the best fitting corneal portion of a trial aspherical contact lens plus the added refraction required. The corneal curve of the trial lens, the added refraction and the vertex distance between the contact lens and the refracting lenses are all stated when the finished lenses are ordered.

A sodium borate-boric acid buffer solution made up to the p_H of the patient's lacrimal fluid is most satisfactory to use as the fluid lens.

Not all patients can wear the most perfect fitting contact lenses for periods over two hours, even though they clear the cornea and limbus and conform to the irregularities of the sclera. More research must be carried out to determine the reason for the establishment of tolerance with some eyes and the cause of various degrees of intolerance of other eyes.

STRENGTH OF EPINEPHRINE COMPOUNDS IN OPHTHALMOTHERAPY

A NEW EPINEPHRINE OINTMENT

JOSEF D. WEINTRAUB, M.D.

CINCINNATI

Solution of epinephrine hydrochloride U. S. P. is described as having a strength of 1:1,000, or 0.1 per cent, but not of epinephrine hydrochloride, rather of epinephrine base. For a long time the drug in this concentration has been instilled into the eye; it has been used therapeutically to relieve congestion and the attending symptoms in various superficial conjunctival conditions, and diagnostically to blanch the surface vessels and thus render more apparent a suspected deeper perikeratic or ciliary flush or injection. Since 1913 it has been injected subconjunctivally.¹ Since 1925 it has been used on pledgets of cotton placed in the conjunctival sac.²

When, in 1931, there was described the use of a stronger solution of epinephrine³ to dilate the pupil, to distend and break iridolenticular synechiae and to reduce the tension in cases of glaucoma, this same principle of designating strength was used. The convenient, water-soluble bitartrate of synthetic levo-epinephrine was placed on the market in an ampule containing 0.091 Gm. of the salt, equivalent to 0.050 Gm. of epinephrine base, and the percentage strength of the solution was calculated from the epinephrine base content. If the contents of the ampule were dissolved to make 5 cc. of solution, it was designated 1 per cent epinephrine; if the contents were dissolved to make 2.5 cc. of solution, it was designated 2 per cent epinephrine, meaning 1 per cent and 2 per cent, respectively, of the base and not of the salt. These solutions of epinephrine bitartrate did not keep well. In 1935 there was placed on the market a more stable solution of epinephrine hydrochloride containing 1 per cent epinephrine. Although marketed originally for spraying into the nose and pharynx,⁴ many oculists, including myself, have been using it to replace the extemporaneously

1. Erdmann: Ueber subkonjunktivale Injektionen von Nebennierenpräparaten und ihre therapeutische Verwendung, *Klin. Monatsbl. f. Augenh.* **52**:520, 1914.

2. Gradle, H. S.: The Use of Epinephrin in Ocular Hypertension, *J. A. M. A.* **84**:675 (Feb. 28) 1925.

3. Green, J.: Two Per Cent Epinephrine Solutions as Substitutes for Laevoglaucon, *Arch. Ophth.* **5**:350 (March) 1931.

4. Graeser, James B., and Rowe, Albert H.: The Inhalation of Epinephrin for the Relief of Asthmatic Symptoms, *J. Allergy* **6**:415 (July) 1935.

prepared 1 per cent solution of epinephrine for instillation into the conjunctival sac.⁵

In the interim, in 1934, there was introduced a preparation consisting of the epinephrine bitartrate salt in a phenolated tragacanth jelly.⁶ This product had better preservation qualities than the then available aqueous solution and had the therapeutic advantage of remaining in contact longer than an instilled drop. Inadvertently, and unfortunately, the originator and the drug company which proceeded to market the jelly confused ophthalmologists by changing the percentage designation to one calculated from the total epinephrine bitartrate content rather than from the epinephrine base content. The directions were that the contents of the ampule, 0.091 Gm., be put into 4.5 Gm. of phenolated tragacanth jelly; this was designated as 2 per cent epinephrine jelly, although according to the epinephrine base content it would be 1.11 per cent epinephrine jelly. The directions were further that the contents of the ampule, 0.091 Gm., be put into 9 Gm. of phenolated tragacanth jelly; this was designated as 1 per cent epinephrine jelly, although according to the epinephrine base content it would be 0.56 per cent epinephrine (although 1 per cent epinephrine bitartrate) jelly. Compared with the previous mode of designating percentage strength, the epinephrine content now being supplied in jelly according to these formulas is but little more than half the designated percentage, and differences in results might be associated with the marketing of these weaker preparations.

It is well to continue to designate the strength of preparations of epinephrine base or of epinephrine salts according to the epinephrine base content, as otherwise it is impossible to compare directly the effective strengths of the different preparations. This is equivalent to comparing the substances on the basis of chemical molarity, or preferably chemical normality, and recently I have been using and prescribing epinephrine in terms of normality. The formulas for the ointments are as follows:

Epinephrine bitartrate (1 ampule)	0.091 Gm.
Distilled water	1.1 cc.
An oxycholesterol petrolatum ointment base	1.54 Gm.

Dissolve the contents of the ampule in the distilled water, and incorporate the solution well with the ointment base. Put into a narrow-tipped ophthalmic ointment tube.

This ointment is of tenth-normal strength and contains 1.83 per cent of epinephrine base.

Epinephrine bitartrate (1 ampule)	0.091 Gm.
Distilled water	2.2 cc.
An oxycholesterol petrolatum ointment base	3.17 Gm.

Follow the same directions as for the stronger ointment.

5. Barkan, Otto, and Maisler, S.: Adrenalin Chloride in 1:100 Strength in Ophthalmology, California & West. Med. **46**:150, 1937.

6. Alvis, Bennett Y.: Suprarenin Jelly, Tr. Am. Acad. Ophth. **39**:403, 1934.

This ointment is of twentieth-normal strength and contains 0.92 per cent of epinephrine base.

The chemical normality of a solution, jelly or ointment containing epinephrine depends on the molecular weight of the epinephrine compound used; and it is independent of whether the alkaloid or a salt is used and of which salt is used. A tenth-normal preparation of any epinephrine compound always contains the same amount of epinephrine in a comparable quantity of the pharmaceutical preparation, and designating strength in terms of normality is equivalent to designating strength in terms of epinephrine base content. The particular compound used in a preparation depends on solubility, stability and availability. Should a different, and perhaps more suitable, epinephrine salt be made available in the future, it would be possible to continue to use and prescribe such epinephrine preparations in terms of normality; thereby one salt could be compared directly with another salt or with the base. An additional advantage of prescribing epinephrine preparations in terms of normality is the avoidance of the confusion between the two methods of expressing percentage strength—the older in terms of the base and the newer in terms of the salt.

The ointment with the oxycholesterol absorption base is easily made up, much more conveniently than the tragacanth jelly, and keeps for a reasonable length of time. If desired, a preservative and anesthetic, such as chlorobutanol, may be added by using distilled water saturated with chlorobutanol instead of plain distilled water. The base forms with the solution incorporated with it a creamy white ointment, which melts and spreads readily in the conjunctival sac. This base has the advantage over a simple petrolatum menstruum as it is miscible with the tears. It mixes better than the phenolated tragacanth jelly, which does not spread readily and usually is extruded easily and finds a resting place on the lashes. The proportions of water in the formula may be changed, more water being used to make a softer, more readily spreading ointment, or less water to make a stiffer ointment. The ointment is pharmaceutically desirable and easily made extemporaneously. It is therapeutically more appropriate than a tragacanth jelly for the tear-wetted conjunctival and corneal surfaces.

Clinical Notes

NECROSIS OF THE FRONTAL BONE AND OF THE LACRIMAL GLAND

JOSEPH LAVAL, M.D., NEW YORK

A case of necrosis of the frontal bone and of the lacrimal gland is reported.

J. K., a woman aged 28, presented herself at Dr. Fletcher's clinic at the Manhattan Eye, Ear and Throat Hospital on Nov. 17, 1936, complaining of double vision, which was present occasionally when she looked up. This symptom had been somewhat variable for the past six months, during which time there had also been a vague discomfort about the right eye. There was no history of any other ocular disorder.

Examination showed the vision in each eye to be 20/20 without glasses. A firm rounded mass could be felt under the right orbital ridge at its central portion. It was hard but not bony and was about the size of a small pea; moderate tenderness was elicited on pressure. The right upper lid was slightly lower than the left but could be well elevated. Ocular motility was normal in all fields, there being no limitation of upward gaze. With the red glass, however, diplopia could be brought out when the patient looked upward and to the right. Both fundi were normal.

A roentgenogram of the right orbit taken on the day of admission showed the frontal sinuses to be clear and of average size (fig. 1). There was no evidence of involvement of the ethmoid sinuses other than some thickening of the membrane, nor was there any evidence of involvement of the right supra-orbital ridge except for some slight osseous thickening. The Wassermann and Kahn tests of the blood were both negative. Examination of the blood to rule out the remote possibility of leukemia showed 12,000 white blood cells, with 74 per cent polymorphonuclear leukocytes and 26 per cent small and large lymphocytes. The patient was then examined in the department of otolaryngology, where it was suggested that a mucocoele might be present, even though the roentgenogram showed no involvement of the sinuses.

On Jan. 7, 1937, with the patient under ether anesthesia, an incision was made in the skin directly below the right eyebrow down to the superior orbital ridge. Palpation revealed a rounded mass lying along the roof of the orbit under the periosteum. The periosteum was elevated, and the mass, which was about the size of a pea, was freed from the surrounding periosteum. The small mass, together with its enveloping coat of tissue, was then excised. There was found to be no connection with the bony tissue or with the frontal sinus. A small depression was felt in the bony roof of the orbit where the tumor lay. The deep tissues were then approximated with catgut, the wound in the skin was closed with silk sutures and a pressure bandage was applied. Recovery was uneventful.

Examination of the tissue showed some fibrous tissue, which was hyalinized in some areas and more cellular in others. There was also a slight mononuclear inflammatory reaction. A diagnosis was made of fibromatous tissue, probably cicatrix (fig. 2).

The patient was discharged from the hospital on January 11, four days after the operation. About four weeks later she noticed swelling and tenderness temporal to the region of the operation, and a roentgenogram taken at this time, February 4, showed an area of absorption in the supra-orbital ridge at about 10 o'clock. The area did not connect with the frontal sinus, which was clear (fig. 1). No tumor mass could be seen. According to the roentgenographic report, this area was not seen at the first examination on November 17, about two and a half months previously, although a comparison of the first roentgenogram with that taken on February 4 showed the presence of this area of absorption in the former. The swelling gradually increased, and on February 27, a little over seven weeks after the first operation, an incision was made slightly lateral to the region of the

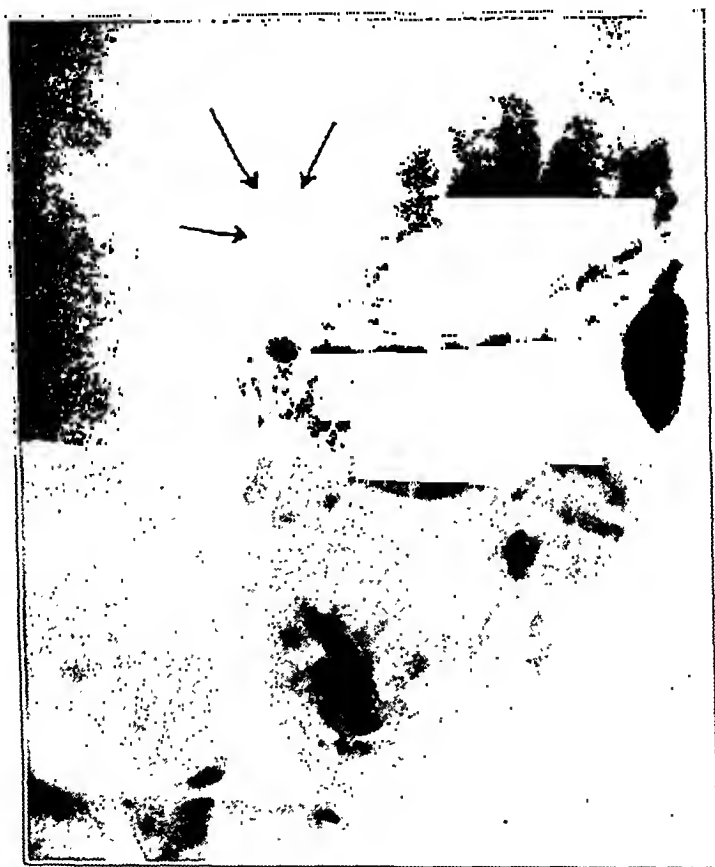


Fig. 1.—Roentgenogram showing clear sinuses. The arrows point to the area of absorption in the supra-orbital ridge at about 10 o'clock.

original operative incision, and much purulent material was disclosed. A drain was inserted, and on March 2, there being no further discharge, the drain was removed, the wound being allowed to close.

Two weeks after the patient's discharge from the hospital, swelling, redness and tenderness appeared again, but this time still more laterally in the frontotemporal region, just beyond the outer limit of the eyebrow. Another roentgenogram taken at this time showed no change in the appearance of the area of absorption in the supra-orbital ridge at about 10 o'clock. On March 16 an incision was made above the right supra-orbital ridge at its extreme temporal area, and a fairly large amount of necrotic and purulent tissue escaped. The incision was carried down to the bone, and more and more of the necrotic material escaped. With

the finger a deficiency in the frontal bone was palpated, through which a probe was inserted into the region of the lacrimal gland. The end of the probe could be palpated lying in the upper fornix and could be seen beneath the conjunctiva. The area of deficiency in the frontal bone was well curetted and was found to be a round hole large enough to admit the tip of the small finger. The deficiency extended down almost to the superior orbital ridge, which was intact and uninvolved. The necrotic tissue of the lacrimal gland was removed, and a rubber drain was inserted through the hole. Two silk sutures were placed in the skin. On March 26 the area was entirely healed, and the patient was discharged. A roent-

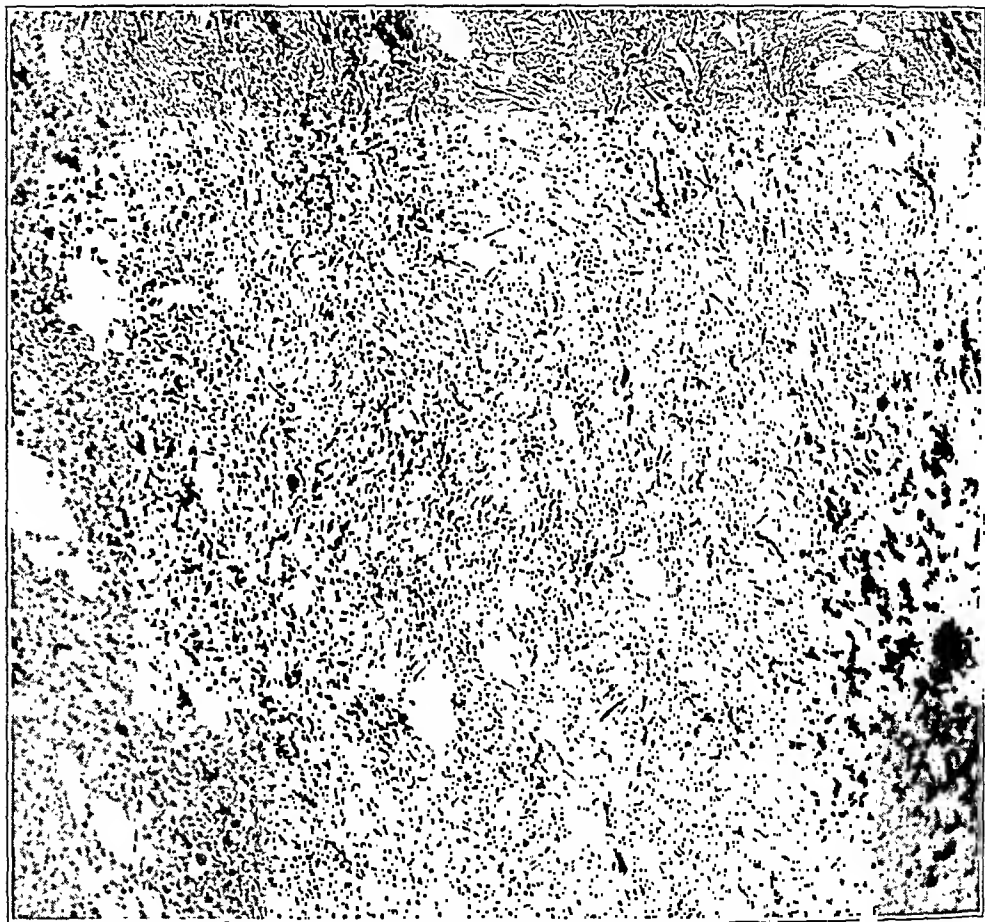


Fig. 2.—Photomicrograph showing areas of fibrous tissue, some hyalinized and some quite cellular.

genogram of the same area taken on March 30 showed no change since the two previous examinations, on February 4 and March 16.

Examination of the tissue showed necrotic, poorly staining masses of broken-down cells, the original nature of which could not be determined. Some large hydropic cells were seen, which may have been edematous tissue of the lacrimal gland. Mononuclear infiltration was fairly pronounced, and some purulent areas were also seen. The picture resembled that seen in granuloma (fig. 3).

Several days after the last operation the patient stated that three years previously she fell, striking the right side of her head. Some gravel became

impacted in the region of the right brow at this time. Two years prior to the present trouble and again a year before, the same accident befell her. The patient also admitted that on each of these occasions she had been moderately intoxicated.

This case is interesting for two reasons: First, it shows how easily my associates and I were mislead by paying attention to the most prominent symptom, diplopia on upward gaze, and to the most prominent sign, palpation of a firm hard nodule in the orbit. Second, it demonstrates how important it is to get a complete history. I am sure that



Fig. 3.—Photomicrograph showing necrotic, poorly staining tissue. The arrows point to large hydropic cells, which may have been edematous tissue of the lacrimal gland.

if the history of repeated trauma with the impaction of foreign particles in the region of the right brow had been obtained originally we would have paid more attention to the roentgenogram of this region instead of to that of the orbit as a whole. In that case I believe that the roentgenogram taken in November would have revealed the area of absorption in this region instead of first showing it in February, a month after the first operation.

The fibrous tissue which was removed at the first operation played no part in the production of any of the symptoms or signs. Most likely it was cicatricial tissue resulting from repeated trauma and hemorrhage in this region.

FREE CYST IN THE ANTERIOR CHAMBER

DON MARSHALL, M.D., DANVILLE, PA.

Justification for reporting a case of free cyst in the anterior chamber lies only in the fact that the condition is rare. The literature and theories as to etiology have been well reviewed recently by Clapp¹ and by Evans.² Their publications include good illustrations of the gross and the microscopic structure. Evans found thirty-two reported cases of free cyst in the eyeball, but in only nineteen of these was the cyst in the anterior chamber; to this number he added a case of his own. At least two other cases³ have been described in foreign periodicals since 1928.

The type of cyst here considered is usually less than 2 mm. in its greatest diameter, globular or ovoid and semitransparent, with pigment granules scattered in or over its surface. The outer wall, or capsule, is extremely thin. The contents are clear and fluid. In a few cases the cyst has been kidney shaped or has contained a fold as though made by a constricting band. The specific gravity of such cysts must be greater than that of the aqueous or the vitreous, for in the reported cases the cyst has always settled to the bottom of either the anterior or the vitreous chamber by gravity. Usually the eye otherwise is normal, and the cyst gives rise to no symptoms other than obstruction to vision when it floats across the visual axis and the defect in the cosmetic appearance when it lies in a visible position in the anterior chamber.

A few cysts have been removed surgically from the anterior chamber and, as in Evans' case, on microscopic examination have been found to have a wall of pigment epithelium, derived probably from the iris. Nothing has been observed inside these cysts on microscopic examination.

A study of the recent literature leads to the conclusion that there can no longer be much doubt that a cyst of this type arises from the pigment layer of the iris or the ciliary body. The origin has been discussed for many years. Villard and Dejean⁴ in 1933 stated that the mode of

From the Department of Ophthalmology, the George F. Geisinger Memorial Hospital.

1. Clapp, C. A.: Free Cyst in Anterior Chamber, *Am. J. Ophth.* **11**:862 (Nov.) 1928.

2. Evans, W. H.: Free Cyst Floating in the Anterior Chamber: Report of Case, *Arch. Ophth.* **15**:822 (May) 1936.

3. Blidstein-Nevoroshkina, N. I.: Free Cyst in the Anterior Chamber, *Russk. j. oftal.* **14**:361 (Oct.-Nov.) 1931. Hambresin, L.: Kyste mobile de la chambre antérieure, *Bull. et mém. Soc. franç. d'opht.* **45**:145, 1932.

4. Villard, H., and Dejean, C.: Les kystes de l'iris, *Arch. d'opht.* **50**:91 (Feb.); 194 (March); 272 (April) 1933.

development of a wandering cyst is not well understood, but its origin from the iris does not seem to be doubted. A cyst of this type attached along the pupillary margin of the iris has been described in detail and in varying stages of development by Wilmer,⁵ Town⁶ and Cowan.⁷ In recent years reports of cysts of identical characteristics but free in the vitreous chamber have been reviewed by Scarlett,⁸ Hurwitz,⁹ Seech¹⁰ and Meding,¹¹ while reports of similar bodies free in the anterior chamber have been reviewed by Clapp and Evans.

REPORT OF A CASE

E. E., a boy of 11 years, was first examined on April 14, 1937, having been referred by an optometrist because of a black object in the anterior chamber of the left eye. This had first been discovered only four days previously by the boy's mother. She had found that it was not fixed in position. No other ocular symptoms were present. There was no history of ocular disease or injury. The mother felt positive that the cyst had not been visible in the eye two weeks before. The patient had not noted any visual disturbance.



Free cyst in the anterior chamber, depicted as a dark object in the angle temporally. The four white spots are highlights on the cornea.

Examination showed an uncorrected visual acuity of 20/15 in each eye. The irides were dark blue or gray, with normal distribution of pigment and no gross

5. Wilmer, W. H.: Cyst of Uveal Layer of Iris at Pupillary Margin, *Arch. Ophth.* **1**:162 (Feb.) 1929.

6. Town, A. E.: Cyst of the Uveal Layer of the Iris, *Am. J. Ophth.* **16**:790 (Sept.) 1933.

7. Cowan, A.: Congenital and Familial Cysts and Flocculi of the Iris, *Am. J. Ophth.* **19**:287 (April) 1936.

8. Scarlett, H.: Floating Cyst of the Vitreous, *Arch. Ophth.* **2**:619 (Nov.) 1929.

9. Hurwitz, C. E.: Cyst in the Vitreous: Report of Case, *Arch. Ophth.* **9**:825 (May) 1933.

10. Seech, S. G.: Congenital Cyst in Vitreous, *Arch. Ophth.* **11**:947 (June) 1934.

11. Meding, C. B.: Free Cyst Floating in the Vitreous, *Arch. Ophth.* **11**:973 (June) 1934.

clumping. There was a narrow dark brown line of pigment in each eye along the pupillary margin of the iris, of normal size and appearance, as seen under magnification. There were no cysts or other abnormalities or variations in this layer of pigment either when the pupils were dilated or when they were small.

The right eye showed no pathologic process. The left eye was normal and similar to the right, except for a dark brown sausage-shaped body, 2 mm. long and 0.67 mm. in diameter, free in the anterior chamber. One end was rounded; the other end was slightly conical, and near it there was a bend or partial fold in the side of the cyst. The cyst was translucent, with fine particles of pigment scattered somewhat irregularly over its surface. Examination with the slit lamp showed no evidence of strands or connections to other ocular structures, nor were there any vessels or other visible structures inside the cyst. The surface was regular and without projections. The cyst did not move by itself, but when the position of the eyeball and head was varied it would move slowly by gravity to any position in the anterior chamber. With the patient lying on his back, the cyst rested on the iris.

The lens, vitreous and fundus were normal. No other ocular pathologic process was found in either eye. The patient was instructed that surgical removal of the cyst could easily be performed but that such a procedure was not urgent in the absence of symptoms or other ocular disease. No surgical treatment was attempted.

FEVER THERAPY FOR OCULAR DISEASES

JOHN S. McGAVIC, M.D.

CINCINNATI

The empiric therapeutic use of artificially induced fever had its origin in antiquity. Only in the last two decades has there been notable progress in the rational or scientific use of fever in combating disease.

The present activity in the field of fever therapy began in 1918, when Wagner-Jauregg published his excellent work on the treatment of dementia paralytica with induced malaria. Nonspecific protein therapy had been introduced only a short time prior to this. In the past six years the production of hyperpyrexia by physical means has been widely studied.

Innumerable diseases of widely divergent character have been treated with fever therapy with equally varying results. Some interest has already been exhibited in this form of therapy by ophthalmologists, particularly in the treatment of syphilitic ocular diseases and gonorrheal ophthalmia and, to a lesser extent, in the treatment of corneal ulcers and iritis of nonspecific origin. After consideration of the rationale of fever therapy, it did not seem unlikely that other diseases of the eye might respond to this treatment.

During the past three years 50 patients with fourteen ocular diseases have received fever therapy at the Cincinnati General Hospital. The first patients were those who had failed to respond to the classic methods of treatment and were in the so-called "hopeless" class. Later, treatment was started earlier in the course of disease, and different types of lesions were treated more or less experimentally.

PURPOSE

This paper is based on the aforementioned series of 50 cases of fourteen ocular diseases in which treatment with one mechanical device, the Kettering hypertherm, was administered. It is my purpose to

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report the manner of treatment, the results obtained, and the complications encountered, together with the method of avoidance and the management of these complications. When other treatment was administered, this is noted. An attempt has been made to compare in general the results obtained in cases in which fever therapy was used with those obtained in similar cases in which fever therapy was not employed.

The diagnoses in these 50 cases were as follows:

	No. of Cases
Gonorrheal conjunctivitis	11
Gonorrheal iridocyclitis	1
Syphilitic interstitial keratitis.....	10
Syphilitic iridocyclitis	11
Syphilitic atrophy of the optic nerve.....	1
Meningovascular syphilis, with paralysis of the intrinsic and extrinsic ocular muscles.....	1
Meningococcic abscess of the vitreous.....	2
Phlyctenular keratoconjunctivitis	4
Tuberculous parenchymatous keratitis.....	1
Tuberculous keratitis and iridocyclitis.....	1
Corneal ulcer	2
Severe conjunctivitis due to gram-positive diplococci.....	1
Allergic conjunctivitis	1
Nonspecific uveitis	2
Conjunctivitis, with marginal corneal ulcers.....	1

This series is obviously too small to be of great value, and one must realize that no definite conclusions should be drawn after observing so few cases. However, a few observations may be of interest to others. In 4 cases the eyes were hopelessly lost when fever therapy was started as a last resort. In 4 cases only a single treatment was administered, so that the results are of no statistical value. These cases are included in order to report every case of ocular disease in which treatment with the Kettering hypertherm was administered.

DESCRIPTION OF KETTERING HYPERTHERM

In its present state the Kettering hypertherm consists of an insulated cabinet in which the nude patient lies, with his head extending outside the cabinet. Insulation with sponge rubber is utilized in the region where the neck projects to permit the patient to shift his position. The patient lies on an air mattress, supported by a boxlike bed, which is rolled in and out at will. In the rear of the cabinet is a small insulated fireproof compartment in which the air-conditioning apparatus is housed. The temperature of the air, as recorded with a dry bulb thermometer, is controlled by a thermostat. The percentage of relative humidity is controlled by a humidistat. The velocity of air within the cabinet is controlled by blowers of fixed speed. The average set of air conditions

to which the patient's body is subjected during the induction of fever is as follows: temperature (dry bulb) of from 130 to 150 F. (from 54 to 65 C.), relative humidity of from 35 to 50 per cent, and velocity of air of 425 cubic feet per minute. The elevation of the rectal temperature to 105 F. (41 C.) is ordinarily accomplished in from forty minutes to one hour. During the maintenance of fever the temperature and velocity of air are reduced. The air is constantly conditioned by continuous passage through the air-conditioning compartment. The



The Kettering hypertherm.

safety and comfort of the patient are greatly enhanced by the accurate control of the relative humidity.

The mechanism of the induction of fever with the Kettering hypertherm depends primarily on the transfer of heat by conduction from the circulating heated air. This factor, combined with prevention of the normal rate of loss of heat from the body by radiation and evaporation, is responsible for the elevation of the body temperature and its maintenance at any desired level.

The simplification of the apparatus and the removal of hazards inherent in certain other physical modalities have converted this form

of therapy from one requiring hospitalization of the patient to one which usually permits him to return to work the day after treatment.

Fifty-five of these units have been lent to twenty medical research centers, strictly for investigative purposes. The physicians and nurses charged with this undertaking received special training in the department of fever therapy research at the Miami Valley Hospital before the apparatus was released. A simpler, smaller and less costly apparatus is now being developed. It is probable that it will ultimately be available on a loan-lease basis to certain qualified institutions.

TECHNIC OF TREATMENT

The successful administration of treatment with the hypertherm depends on the following factors: (1) the selection of patients from the standpoint of physical condition and mental stability, (2) the proper psychologic conditioning, (3) the medical preparation of the patient and medical care while the treatment is in progress and (4) the nursing care.

Each patient is examined to rule out any of the following conditions considered as contraindications: age above 60, cardiovascular disease (excepting acute rheumatic carditis), renal disease, active pulmonary tuberculosis, hypertension regardless of cause, and diabetes unless carefully controlled. Desjardins and his co-workers¹ do not consider well controlled diabetes as a contraindication.

Simpson^{1a} reported the successful treatment of 3 pregnant women who gave birth to full term, normal babies. One patient had acute gonorrheal arthritis, and 2 had advanced dementia paralytica which had resisted all other forms of treatment. The two babies were non-syphilitic.

Before a patient is sent to the department of fever therapy for his first treatment, he is told as much about it as seems advisable. An attempt is made to anticipate, and then to dissipate, his fears and to send him away as composed and cooperative as possible. For some reason, cooperative patients seem to obtain better results.

The patient receives the following preparatory routine: (1) 250 cc. of orange juice and 250 cc. of 5 per cent dextrose the night before treatment; (2) a mild sedative at bedtime; (3) 20 grains (1.29 Gm.) of calcium lactate at bedtime; (4) orange juice, dextrose and calcium lactate in the morning, in the same quantities as given the night before;

1. Desjardins, A. U.; Stuhler, L. G., and Popp, W. C.: Fever Therapy for Gonococcic Infections, *J. A. M. A.* **104**:873 (March 16) 1935.

1a. Simpson, W. M., in discussion on Hartman, F. W., and Major, R. C.: Abstracts of Papers and Discussions, Fifth Annual Fever Conference, Dayton, Ohio, May 1935.

(5) a light breakfast, or none, and a cleansing enema, and (6) 10 cc. of calcium gluconate intramuscularly just before treatment.

During the period of fever treatment intelligent nursing care is of the utmost importance. One nurse is constantly with the patient. Every means of providing as much physical comfort as possible is employed. Constant reassurance relieves the understandable anxiety experienced by the patient. Were it not for the excellence of the nurses, who are vitally interested in their work, much more opposition and many more complications would be encountered.

The nursing care of the patient in the box is as follows:

1. The head is outside of the box. This does not affect the temperature of the eye, even though the head is sponged frequently with ice. The patient is covered with blankets in the box.

2. The period of induction is from one to one and one half hours' duration, during which time sedation is given when necessary. Sedation is kept at an absolute minimum; $\frac{1}{6}$ grain (0.01 Gm.) of pantopon (a mixture of the hydrochlorides of the opium alkaloids) or $\frac{1}{2}$ grain (0.03 Gm.) of codeine sulfate (administered hypodermically) may be used. Barbiturates are not recommended as the patients have peculiar mental reactions. The use of morphine is avoided as it often causes nausea and vomiting.

3. Fluids are withheld until fever is attained.

4. A temperature of from 105 to 107 F. is maintained for five hours.

5. As much cool 0.6 per cent saline solution is given by mouth as the patient will take. This is well tolerated and helps maintain the chloride balance.

6. No local treatment is given to the eyes during fever therapy, except in cases of gonorrheal conjunctivitis, when they are kept free from pus.

7. The blankets are changed frequently and the patient is rubbed with ice.

8. The temperature is taken rectally every five minutes.

9. The pulse is counted every ten or fifteen minutes.

10. The blood pressure is taken if other signs indicate the necessity.

The after-care of the patient consists of the following measures:

1. Covers are removed near the end of the treatment.

2. The patient is removed from the box.

3. A bath with soap and water is given.

4. The patient is watched closely for one hour. The blood pressure, pulse rate and temperature are taken three or four times. The temperature usually falls in one-half hour to 100 F.

5. The patient is returned to the ward and remains in bed until he wants to get up. If he is an outpatient, he may go home two hours after completion of the treatment.

GONORRHEAL INFECTION OF THE EYE

The rationale of the fever treatment of gonococcic infections is definitely established. Neisser and Scholtz^{1b} had difficulty in cultivating the gonococcus in patients with fever. Remissions and even cures had been noted in patients having intercurrent febrile diseases. Laboratory workers found that the organism grew poorly on artificial mediums at temperatures above 100 to 104 F. The gonococcus resists high temperature better in vivo than in vitro (Koch and Cohn²).

Wagner-Jauregg credited Bering³ with having introduced malaria for the treatment of gonorrhea in 1924.

Injections of foreign protein and chemicals have also proved successful. Boak, Carpenter and Warren⁴ paved the way to the successful clinical application of fever therapy by studying the thermal death gradient of many strains of gonococci. They proposed to find how long it would take to kill each strain at temperatures tolerable to man.

Carpenter, Boak, Mucci and Warren⁵ stressed the importance of knowing the thermal death time of the particular strain of gonococcus involved, so that treatment might be given accordingly. They found that in fifteen strains 99.7 per cent of the organisms were killed after from four to five hours at 105.8 F. and 99 per cent were nonviable after two hours at 105.8 F. The remaining 1 per cent were killed in from five to twenty hours at a temperature of from 106 to 107 F. Simpson and his co-workers⁶ repeated this experiment, with almost

1b. Neisser, A., and Scholtz, W.: *Gonorrhoe*, in Kolle, W., and Wassermann, A.: *Handbuch der pathogenen Mikroorganismen*, Jena, Gustav Fischer, 1903, vol. 3, p. 168; cited by Kendall, Webb and Simpson.⁶

2. Koch, J., and Cohn, A.: *Gonokokkeninfektionen*, in Kolle, W.; Kraus, R., and Uhlenhuth, P.: *Handbuch der pathogenen Mikroorganismen*, ed. 3, Jena, Gustav Fischer, 1928, vol. 4, p. 705; cited by Desjardins, Stuhler and Popp.¹

3. Bering, quoted by Wagner-Jauregg, J.: *Message from Prof. Wagner-Jauregg*, Proc. First Internat. Conf. Fever Therapy, December 1937.

4. Boak, R. A.; Carpenter, C. M., and Warren, S. L.: *Thermal Death Time of One Hundred and Thirty Strains of Neisseris Gonorrhoeae*. Idea: The Basic Principles for the Cure of Gonococcal Infections by a Single Fever Treatment, Abstracts of the Fifth Annual Fever Conference, Dayton, Ohio, May 1935.

5. Carpenter, C. M.; Boak, R. A.; Mucci, L. A., and Warren, S. L.: *Studies on the Physiologic Effects of Fever Temperatures*, J. Lab. & Clin. Med. **18**:981 (July) 1933.

6. Kendell, W. H.; Webb, W. W., and Simpson, W. M.: *Artificial Fever Therapy of Gonorrheal Arthritis*, Am. J. Surg. **24**:428 and 452 (Sept.) 1935.

identical results. Krusen, Stuhler and Randall⁷ advocated a single ten hour treatment at 106 F., lest the organism become more heat resistant by frequent temperature elevations of lesser duration.

Many scattered reports have been uniformly favorable concerning the results of fever treatment in practically all gonococcic infections.

Metz,⁸ Hasler and Spekter,⁹ Janet and Dreyfus,¹⁰ Belt and Folkenberg¹¹ and Trautman, Stroupe and Devlin¹² have reported successful treatment of a few patients with gonorrheal ophthalmia by hyperpyrexia.

Report of Seven Cases of Gonorrheal Conjunctivitis.—Response to fever therapy in 11 cases of gonorrheal ophthalmia was most satisfactory. As stated previously, most strains of the gonococcus are killed directly by the temperature attained. Some strains are more heat resistant, and the response in these cases may require some other explanation. Until some method of determining what defense mechanism is stimulated and how this is accomplished by any method, one must be content to assume that "some beneficial reaction" occurs. It is, of course, most probable that all strains can be killed at temperatures safe to use therapeutically, if maintained for sufficiently long periods.

Heat therapy seems to increase the amount of pus formed in the conjunctival sac after the first and second treatments. Thereafter the discharge steadily diminishes, and smears become negative in from about one-third to one-half the time required in cases in which local treatment without heat is used. Additional treatment consists in the following measures: special nursing care, keeping the eyes as nearly free from pus as possible, irrigations with a bland solution (a solution of potassium permanganate in a concentration of 1:10,000) and dilation of the pupils with atropine.

In no patient with clear, uninvolved corneas on admission to the hospital did corneal ulceration or clouding develop after treatment. In the 5 patients who had corneal involvement on admission, no increase in clouding occurred. It appears that the end results were better in these cases than in similar ones in which treatment did not include fever therapy. This is difficult to determine, as many clouded or ulcerated corneas finally become completely, or almost completely, clear after the usual local treatment; this is especially true in infants and very young children. One cannot draw definite conclusions concerning corneal involvement until more patients and more controls are available.

7. Krusen, F. A.; Stuhler, L. G., and Randall, L. M.: Fever Therapy Plus Additional Local Heating in the Treatment of Gonorrheal Infections, Proc. First Internat. Conf. Fever Therapy, December 1937.

8. Metz, M. H.: Results Obtained by the Use of Fever Therapy, J. A. M. A. **106**:1658 (May 9) 1936.

9. Hasler, W. T., Jr., and Spekter, L.: Artificial Fever in the Treatment of Gonorrheal Ophthalmia, J. A. M. A. **107**:102 (July 11) 1936.

10. Janet, J., and Dreyfus, M. R.: La pyrétothérapie des affections gonococciques, Ann. d. mal. vén. **32**:421 (June) 1937.

11. Belt, A. E., and Folkenberg, A. W.: Incidence of Cure in Gonococcal Infections Subjected to One Hyperpyrexia Treatment of Ten Hours' Duration at 106.8 F., Proc. First Internat. Conf. Fever Therapy, December 1937.

12. Trautman, J. A.; Stroupe, H. V., and Devlin, D. J.: Fever Therapy in Gonococcal Infections, Proc. First Internat. Conf. Fever Therapy, December 1937.

Two of the 11 patients had spontaneous rupture of the cornea shortly after admission. Both had been neglected when first seen. Fever treatments were continued to clear up the purulent discharge and to lessen the likelihood of infection of the second eye. Healing was rapid in both instances.

Two patients had concurrent arthritis, which responded to heat therapy with rapidity and completeness. No recurrence of arthritis had occurred after ten and three months, respectively. Four patients had gonorrheal urethritis during the time of treatment.

The more rapidly a gonococcic infection of the conjunctiva can be cured and the more nearly free from pus the conjunctival sac can be

TABLE 1.—Data on Eleven Cases of Gonorrheal Conjunctivitis

Patient	Age, Years	Extent of Involvement*	Days in Hospital	Number of Days Positive	Number of Treatments	Total Hours of Treatment	Corneal Ulceration	Perforation	Residual scar	Final Vision†
A. A.	20	O. S.	20	2	3	2½	3 mm.; shallow	No	Nebula	20/20 and 20/15
J. D.	6	O. S.	14	2	3	16	4 mm.; shallow	No	Nebula	Reading vision in each eye
R. T.	53	O. D.	54	6	4	5½	8 by 3 mm.; deep ulcer near limbus	No	Crecentic leukoma	20/30 and 20/20
F. R.	9	O. U.	32	4	6	19½	6 by 8 mm.; deep ulceration in left eye	Yes	Entire cornea opaque	20/30 and perception of light
J. L.	22	O. S.	16	3	5	15	Tiny superficial ulcer at limbus	No	None	20/30 and 20/30
G. F.	9	O. S.	9	3	2	11	None	No	None	20/30 and 20/30
B. W.	4	O. U.	8	1	2	6	None	No	None	20/20 and 20/20
M. B.	9	O. S.	10	1	2	9½	None	No	None	20/20 and 20/20
P. H.	22	O. U.	40	10	9	38	5 by 5 mm.; deep central ulcer in left eye	Yes	Entire cornea opaque	20/20 and perception of light
R. J.	4	O. D.	21	18	1	5	None	No	None	20/20 and 20/20
W. C.	13	O. U.	7	2	3	15	None	No	None	20/20 and 20/20

* O. U. indicates each eye; O. D., the right eye, and O. S., the left eye.

† Reading vision is equivalent to about 20/40.

kept by the nurses, the less likelihood there is of corneal damage from the toxins present. Therefore, it seems that heat treatments should be given as frequently as the patient can tolerate them.

It is to be regretted that newborn infants with gonorrheal conjunctivitis cannot be treated by fever, as such patients are in the majority, although the infection is usually less severe than in adults.

Recently 4 patients with gonorrheal conjunctivitis were treated with sulfanilamide, given orally in doses of from 40 to 90 grains (2.59 to 5.82 Gm.) a day. The results were satisfactory. Two of the patients had gonorrheal urethritis, which responded clinically in five and six days, respectively. In 1 a low grade fever developed, and the patient was somewhat cyanotic during the period of administration of the drug.

Both of these complications subsided after the sulfanilamide was discontinued. This drug can be given to infants as well as to adults.

If further study of this method of treatment proves that it is effective, fever therapy will certainly be supplanted by this safer, cheaper and more comfortable management. It is too early to be able to state definitely how efficacious sulfanilamide will be, but the reports so far made justify its use under carefully controlled conditions. About from 10 to 15 per cent of patients cannot tolerate sulfanilamide.

Report of a Case of Gonorrheal Iridocyclitis.—The patient was admitted from the clinic with exudative iridocyclitis attributed to the gonococcus. Other than gonorrheal urethritis, no cause for the iridocyclitis could be found. A few gram-negative diplococci were found in conjunctival epithelial scrapings. No purulent conjunctivitis was present, and none developed. The tension was elevated, and posterior synechiae and hypopyon were present. After fever therapy the patient had a prompt subsidence of the congestion of the iris; the synechiae were broken (atropine was used locally); the hypopyon absorbed rapidly, and the tension was reduced to normal without paracentesis being necessary. Three treatments, comprising a total of thirteen hours of therapy, were sufficient to accomplish complete cure. Final vision was 20/25 in each eye.

OCULAR SYPHILIS (INTERSTITIAL KERATITIS, IRIDOCYCLITIS AND ATROPHY OF THE OPTIC NERVE)

Ocular syphilis has presented no less a problem than other manifestations of the disease. Crisp,¹³ an ophthalmologist, once wrote an editorial entitled "The Incurability of Syphilis," basing it on the many recurrences of ocular manifestations in patients receiving adequate chemotherapy for many years and having negative serologic reactions consistently. It is not strange, therefore, that many workers have sought another method of treatment when chemotherapy has failed to cure a disease which causes at least 10 per cent of all blindness.

There are adequate experimental and clinical data to support the premise that syphilitic lesions respond favorably to hyperpyrexia.

Eighteen years ago Weichbrodt and Jahnelt^{13a} reported that scrotal chancres in rabbits whose temperatures were elevated to 104 and 107 F. in incubators for thirty minutes once or twice daily for from three to five weeks healed more rapidly than chancres in untreated rabbits. After the second day the spirochetes lost their motility, decreased in number and disappeared.

13. Crisp, W. H.: The Incurability of Syphilis, *Am. J. Ophth.* **16**:821 (Sept.) 1933.

13a. Weichbrodt, R., and Jahnelt, N.: Einfluss hoher Körpertemperaturen auf die Spirochaeten und Krankheitserscheinungen der Syphilis in Tierexperiment, *Deutsche med. Wchnschr.* **45**:483 (May 1) 1919.

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In 1926 Schamberg and Rule¹⁴ were able to prevent the development of syphilitic lesions in rabbits whose testes had been inoculated with spirochetes by daily elevation of the temperature of 4 degrees F. They also cured definite chancres of the scrotum by fifteen daily elevations of the temperature of from 5.2 to 5.8 degrees F. No spirochetes were found after eight days; the testes were normal in seventeen days. Furthermore, they could not produce syphilitic lesions in other rabbits by the injection of popliteal and inguinal lymph node tissue from the infected and heat-treated rabbits into the testes of normal rabbits.

The same workers¹⁵ treated 11 syphilitic persons with hot baths and noted regression of eruptive lesions and favorable serologic reactions in practically all.

Bessemans and his co-workers¹⁶ were able to cure or prevent scrotal chancres in rabbits by local or general hyperpyrexia of 104 F. for two hours, or 107.6 F. for one hour (intratesticular temperatures as measured by the thermopile).

Carpenter, Boak and Warren¹⁷ showed that experimental syphilis in rabbits could be effectively treated by hyperpyrexia. They studied the thermal death gradient of *Spirochaeta pallida* in vitro. Temperatures of 102.2 F. for five hours, 104 F. for three hours, 105.8 F. for two hours and 106.7 F. for one hour were required to render material from infected, treated rabbits noninfectious to other rabbits. Levaditi and

14. Schamberg, J. F., and Rule, A. M.: Studies in the Therapeutic Effect of Fever in Experimental Rabbit Syphilis, *Arch. Dermat. & Syph.* **14**:243 (Sept.) 1926.

15. Schamberg, J. F., and Rule, A. M.: The Effect of Extremely Hot Baths in Experimental Syphilis, *Arch. Dermat. & Syph.* **17**:322 (March) 1928.

16. Bessemans, A.; de Potter, F., and Hacquaert, R.: Sur deux formes d'aéro-thermothérapie locale des syphilones testiculaires primaires du lapins, *Compt. rend. Soc. de biol.* **100**:757 (March 15) 1929. Bessemans, A.; Vercoullie, J., and Hacquaert, R.: Nouvel essai de thermoprophylaxie sociale antisiphilitique; traitement aère-thermique local du chancre primaire, *Rev. belge sc. méd.* **1**:425 (May) 1929; Influence de diverses applications locales de la chaleur sur les accidents syphilitiques primaires et secondaires chez l'homme, *Compt. rend. Soc. de biol.* **101**:483 (June 14) 1929. Bessemans, A.: Local Application of Heat as an Adjunct in the Social and Individual Prophylaxis of Syphilis: Role of Tissue Temperature in Pathogenesis and General Pyretotherapy of Syphilitic Infection, *Urol. & Cutan. Rev.* **34**:71 (Feb.) 1930. Bessemans, A., and Thiry, U.: New Experiences with the Application of Local Heat Therapy (Hot Water Baths and Diathermy by Long Waves Slightly Damped) in the Treatment of Primary and Secondary Syphilis in Man, *ibid.* **37**:377 (June) 1933; cited by Simpson.²⁰

17. Carpenter, C. M., and Boak, R. A.: Effect of Heat Produced by an Ultra-High Frequency Oscillator on Experimental Syphilis in Rabbits, *Am. J. Syph.* **14**:346 (July) 1930. Boak, R. A.; Carpenter, C. M., and Warren, S. L.: Healing of Experimental Syphilis in Rabbits by Short Wave Fevers, *J. Exper. Med.* **56**:751 (Nov.) 1932; Thermal Death Time of *Treponema Pallidum* in Vitro, with Special Reference to Fever Temperatures, *ibid.* **56**:741 (Nov.) 1932.

de Rothschild¹⁸ performed similar experiments, with less constant results.

Kolmer and Rule¹⁹ were able to prevent infection and to cure experimental syphilitic lesions by hot water baths. Injections of typhoid vaccine and of a mixture of erysipelas and prodigiosus toxins were much less effective in this experiment than were hot baths.

Simpson²⁰ and others have done excellently controlled experimental work with equally dramatic results. Kyrle,²¹ Kemp and Stokes,²² Richet and Dublineau,²³ Wagner-Jauregg,²⁴ O'Leary,²⁵ Jacobs and Vohwinkel,²⁶ Bering²⁷ and others have emphasized that chemotherapy combined with fever therapy of any type is more effective than either one alone in the treatment and prevention of neurosyphilis.

With the exception of reports of cases of syphilitic interstitial keratitis, published reports of cases of ocular syphilis in which artificial fever therapy was used are not numerous. In 1925 Huber²⁸ reported the successful use of foreign protein in the treatment of this manifesta-

18. Levaditi, C., and de Rothschild, H.: Etude expérimentale de la thermothérapie générale par les radiations à ondes courtes, *Ann. Inst. Pasteur* **52**:23 (Jan.) 1934.

19. Kolmer, J. A., and Rule, A. M.: Hot Baths in Experimental Primary Syphilis of Rabbits and in Trypanosomiasis of Rats, *Arch. Dermat. & Syph.* **27**: 660 (April) 1933.

20. Simpson, W. M.: Artificial Fever Therapy of Syphilis and Gonococcic Infection, *New York State J. Med.* **36**:1 (Sept.) 1936.

21. Kyrle, J.: Die Malariabehandlung der Syphilis, *Wien. klin. Wchnschr.* **37**:1105 (Oct. 23) 1924; cited by Simpson.²⁰

22. Kemp, J. E., and Stokes, J. H.: Fever Induced by Bacterial Proteins in the Treatment of Syphilis, *J. A. M. A.* **91**:1737 (May 25) 1929.

23. Richet, C., Jr., and Dublineau, J.: Pyrété et chimiothérapie associées dans le traitement de la syphilis du lapin, *J. de physiol. et de path. gén.* **31**:794 (Sept.) 1933. Richet, C., Jr.; Dublineau, J., and Joly, F.: Pyrété et chimiothérapie associées dans la syphilis primaire et secondaire; étude expérimentale et clinique, *Presse méd.* **41**:1649 (Oct. 25) 1933. Richet, C., Jr., and Dublineau, J.: La pyrété-thérapie de la syphilis, *Paris méd.* **1**:197 (March 3) 1934; cited by Simpson.²⁰

24. Wagner-Jauregg, J.: Malariatherapie, *Wien. med. Wchnschr.* **78**:275 (Feb. 25) 1928; Ueber maximale Malariabehandlung der progressiven Paralyse, *Klin. Wchnschr.* **13**:1028 (July 14) 1934.

25. O'Leary, P. A.: Treatment by Malaria in Asymptomatic Neurosyphilis, *J. A. M. A.* **97**:1585 (Nov. 28) 1931.

26. Jacobs, J., and Vohwinkel, K. H.: Die Malariatherapie der Früh und Spätlues, *Dermat. Ztschr.* **57**:321 (Jan.) 1930; cited by Simpson.²⁰

27. Bering, F.: Die Malariabehandlung im Frühstadium der Syphilis des Zentralnervensystems, *Zentralbl. f. Haut- u. Geschlechtskr.* **17**:41 (June 5) 1925.

28. Huber, R.: Keratitis parenchymatosa, *Klin. Monatsbl. f. Augenh.* **75**:252, 1925.

tion of congenital syphilis. Malarial therapy for interstitial keratitis was instituted by Schreiber²⁹ in 1928.

Culler and Simpson³⁰ first reported the use of the Kettering hypertherm in 58 cases of ocular syphilis, representing 7 different manifestations of the disease.

Simpson and Kendell³¹ reported the clinical application of the quantitative Kahn reaction as a reliable and sensitive index to the progress of a syphilitic patient during the course of treatment. This contribution is of great value in all cases and of especial value in certain cases in which the qualitative or diagnostic Kahn reaction remains positive, despite treatment and in the face of definite clinical improvement.

SYPHILITIC INTERSTITIAL KERATITIS.—Since Hutchinson first correlated interstitial keratitis and congenital syphilis, there has been a more or less fatalistic attitude toward the results of treatment. Spicer³² stated that results for 45 untreated patients did not compare unfavorably with those for the 614 treated patients in his series. Fisher,³³ as late as 1927, was doubtful that chemotherapy altered the course of the disease. Carvill and Derby³⁴ in 1925 published a report of the results in the most complete and best controlled series of cases ever cited in the literature. From 756 patients, they selected 100 untreated, or poorly treated, patients and 100 intensively treated patients for comparison. They concluded that chemotherapy had some influence on the prevention of an attack in the second eye and that perhaps antisyphilitic therapy made this attack less severe in some cases. The vision of the treated patients was found to be better than that of the untreated, or poorly treated, patients, and recurrences were much less frequent in the former. They were distinctly dissatisfied with the results of the treatment, even when injections of milk and diphtheria antitoxin were used with chemotherapy.

One reason for this fatalistic attitude is that interstitial keratitis is a self-limited disease. Corneal scars are variable and may become

29. Schreiber, L.: Treatment of Keratitis Parenchymatosa with Malaria, *Ztschr. f. Augenh.* **66**:316, 1928; cited by Culler and Simpson.³⁰

30. Culler, A. M., and Simpson, W. M.: Artificial Fever Therapy in Cases of Ocular Syphilis, *Arch. Ophth.* **15**:624 (April) 1936.

31. Simpson, W. M., and Kendell, H. W.: Experimental Treatment of Early Syphilis with Artificial Fever Combined with Chemotherapy, *Am. J. Syph., Gonorr. & Ven. Dis.* **21**:526 (Sept.) 1937.

32. Spicer, W. T. H.: Parenchymatous Keratitis; Interstitial Keratitis; Uveitis Anterior, London, George Pulman & Sons, 1924; cited by Culler and Simpson.³⁰

33. Fisher, J. H.: Discussion of the Value of Recent Methods of Treatment in the Late Stages of Ocular Syphilis, *Proc. Roy. Soc. Med.* **20**:954, 1927.

34. Carvill, M., and Derby, C. W.: Interstitial Keratitis, Boston M. & S. J. **193**:403 (Aug. 27) 1925.

almost completely absorbed after long periods with or without treatment. A more detailed description of the type of lesion and more accurate reports on the final visual acuity would add greatly to the value of case reports. The difference in prognosis in the vascularized or recurrent types as opposed to that in the type in which there is a central opaque disk of plastic exudate was brought out by Spicer and reemphasized by Culler and Simpson,³⁰ who found that the otherwise most unfavorable type in which a central plastic exudate was present responded best of all to treatment with the hypertherm. They expressed the belief that the reason for favorable reports published by those using injections of malarial organisms and typhoid vaccine was that a similar resolution of this exudate is effected by these agents, whereas chemotherapy does not seem to have much effect on this type of keratitis.

The object of using artificial fever for this disease is to obtain a shortened course, with relief from symptoms, in the hope that the resulting scars will be less dense because of the earlier and more rapid resolution. A discrepancy was noted between the marked immediate relief of pain, blepharospasm, lacrimation and photophobia and the actual clearing of the corneal stroma. This is especially true in cases in which there is corneal vascularization and in which the inflammation has been present for a long time before fever therapy has been started.

Report of Ten Cases of Syphilitic Interstitial Keratitis.—The results in 10 cases of syphilitic interstitial keratitis were more impressive than those in cases of any other type of ocular disease treated. It seemed almost unbelievable that patients who usually stayed in the hospital for from six to eight weeks before being appreciably improved would open the eyes and leave them open after one or two treatments. Response to chemotherapy, atropinization, hot compresses and the best of supportive treatment had been most disappointing in previous cases.

One patient had Clutton's joints; chemotherapy had been tried, with no response, but the condition responded functionally to fever therapy.

Six of the 10 patients had had previous courses of antisyphilitic therapy before admission to the department of fever therapy. Four had no previous treatment. The following results were noted:

1. The more acute the condition, the better was the response, both subjectively and objectively.
2. Subjective relief of photophobia, blepharospasm, pain and excessive lacrimation occurred after the first treatment, and progressive improvement was noted with each successive treatment. This allowed better examination of the eyes and more efficient local treatment.
3. Better dilation of the pupil was obtained with the combined use of atropine and heat than with atropine alone.
4. The period of activity was shortened; hence, the period of hospitalization.
5. Resultant corneal scarring was slight.
6. All the patients had useful vision after the attack.

Heat therapy is apparently most advantageous in the acute stage of syphilitic interstitial keratitis and when considerable exudation into the

corneal stroma is present. Since this is the type which results in the most persistent scar formation, heat therapy used promptly in such cases would seem to be the ideal method of treatment. Certainly anything which shortens the duration of the condition will decrease the amount of residual scarring.

It should be said that there is great variation in the resulting scar in different persons with keratitis, whether untreated or whether treated with chemotherapy alone, with chemotherapy and local treatment combined, with local treatment only, or with any of the foregoing methods combined with the injection of malarial organisms, typhoid vaccine or similar agents. It is therefore difficult to decide how much patients are actually helped and in which ones only slight scarring or vascularization would result if treatment were not given. However, the astounding subjective relief and shortened duration of the attack alone would be sufficient reason for advocating fever therapy.

SYPHILITIC IRIDOCYCLITIS.—Culler and Simpson³⁰ reported 10 cases of syphilitic uveitis with results almost identical with those found in the cases subsequently reported. Benedict and Whitney³⁵ in discussing this report stated that their own results had been excellent. Hambresin and Mawas³⁶ described favorable results with the use of sulfur in oil, malaria and short wave therapy.

Objections may be raised to the advisability of subjecting such patients to so strenuous a treatment when chemotherapy and atropine alone are sufficient in many cases. There are two excellent reasons; first, iritis is most frequently a manifestation of secondary syphilis, and results of fever therapy in this stage are excellent, not only for ocular but for systemic syphilis; second, one cannot anticipate which patients will be so refractile to chemotherapy as to necessitate fever therapy until much damage has been done to the eye.

It seems, therefore, not only permissible but advisable to use fever therapy when a patient first is observed to have syphilitic iritis. The infection is treated at the time the response to fever is best, and the patient may be saved from future ocular lesions or lesion of the vascular or nervous systems. Chemotherapy is given an opportunity to exert its greatest influence on the spirochete during hyperpyrexia.

Report of Eleven Cases of Syphilitic Iridocyclitis.—A year ago 4 cases of syphilitic iridocyclitis of comparable severity, in all of which there were secondary cutaneous manifestations, were studied. Two patients were treated with fever therapy plus the use of atropine locally, while chemotherapy was withheld with the consent of the patients. The other 2 were given chemotherapy plus the use of atropine and hot compresses locally. The objective and subjective

35. Benedict, W. L., and Whitney, E. L., in discussion on Culler and Simpson.³⁰

36. Hambresin, L., and Mawas, J.: Fever Therapy in Ophthalmology, Proc. First. Internat. Conf. Fever Therapy, December 1937.

TABLE 2.—Data on Ten Cases of Syphilitic Interstitial Keratitis

Patient	Age, Years	Extent of Involvement*	Previous Antisyphilitic Treatment	Duration of Treatment Prior to Fever Therapy	Corneal Involvement	Number of Treatments	Total Hours of Treatment	Vision on Admission	Final Vision†
L. L.	10	O. U.	None	21 days	Plastic exudates; iridocyclitis	6	26	Hand movements at 4 feet in each eye	Reading vision in each eye uncorrected
G. C.	12	O. U.	.....	.....	Diffuse vascularization; small amount of exudate	12	47	20/160 and 20/80	20/50 and 20/50 uncorrected
M. W.	10	O. D.	.....	.....	Small areas of vascularization; slight exudation	3	11¼	.....	20/40 and 20/30 uncorrected
E. A.	5	O. S.	None	7 days	Central opaque exudates	9	27	20/30 and perception of light	20/30 and reading vision uncorrected
L. T.	9	O. U.	For 5 mo.	6 mo.	Central opaque exudates; moderate vascularization	11	37	Hand movements at 2 feet in each eye	20/50 and 20/65
L. J.	8	O. U.	For 2 mo.	2 mo.	Exudation and vascularization centrally	6	12	20/200 in each eye	20/20— in each eye
E. W.	9	O. U.	None	3 wk.	Vascularization; slight exudate	13	47	20/200 and hand movements at 2 feet	20/20 and 20/40
M. L.	..	O. U.	None	3 mo. in each eye 2 wk. in right eye	Vascularization and exudation	8	32	.....	20/20 and 20/20
Ea. W.	12	O. S.	3 yrs. ago	3 wk.	Marked vascularization; moderate exudation	6	28	20/200 and 20/40	20/25 and 20/25
J. R.	9	O. D.	None	.....	Marked exudation of entire cornea	4	20	Hand movements at 2 feet in right eye; 20/30 in left eye	Reading vision and 20/30

* O. U. indicates each eye; O. D., the right eye, and O. S., the left eye.

† Reading vision is equivalent to about 20/40.

ocular phenomena were recorded, along with the results of repeated dark field examinations of the cutaneous lesions, all of which were positive when the patients were admitted to the hospital.

All 4 patients had rigid posterior synechiae, muddy congested irides, marked injection of the ciliary body and marked signs of irritation of the iris, with photophobia, pain and excessive lacrimation. Iritis was well established.

The patients who were treated with heat obtained more rapid and complete subjective relief, better dilatation of the pupil, fewer and smaller synechiae and more prompt diminution of the circumcorneal injection. The cutaneous lesions remained positive on dark field examination at least eighteen days after admission of the patients to the hospital, and the lesions faded slowly. The administration of neoarsphenamine was started twenty-five days after admission, and the cutaneous lesions disappeared rapidly thereafter.

The patients treated with neoarsphenamine immediately on admission showed rapid fading of the cutaneous lesions, no spirochetes being found on dark field examination about ten days after admission. However, the iridocyclitis responded much more slowly, and the residual synechiae were broader and more firm. Subconjunctival injections of solutions of atropine and epinephrine hydrochloride failed to break up the synechiae.

The remaining 9 patients in this group of 11 were seen in the clinic earlier in the course of the iridocyclitis. All were given chemotherapy and fever therapy concurrently, and atropine and hot compresses were used locally. In only 2 cases was the condition as severe as that in the 4 cases mentioned previously. Response to fever therapy was rapid, both subjectively and objectively. While the condition in these cases was less severe and treatment was given earlier, the combined fever therapy and chemotherapy seemed to afford more rapid clearing of the objective signs than did heat alone or chemotherapy alone. One of the patients received fever therapy alone for two treatments, which were given one day apart. The iris appeared worse than on admission. A course of treatment with neoarsphenamine was started, and improvement was prompt. The patient had received a previous course of neoarsphenamine some months before, followed by a period in which no treatment was given.

In 1 other patient further dilatation of the pupils and breaking of synechiae were slow and incomplete after heat therapy. The synechiae had been present for one month, and no previous antisyphilitic treatment had been given.

A third patient showed only temporary subjective improvement and no objective improvement after two treatments. A moderately severe reaction occurred from each treatment, and the fever therapy was discontinued. The patient had had some antisyphilitic treatment for one year. For six weeks prior to admission to the hospital severe iridocyclitis and corneal ulcers had been present, which were unaffected by chemotherapy. After this discouraging experience with the two heat treatments, a course of tuberculin was started, because the patient had a positive tuberculin reaction and hilar lymph nodes were demonstrated in a roentgenogram. The response to six injections of tuberculin (purified protein derivative) was amazingly good. The patient has continued to improve slowly after the initial rapid subjective and objective improvement.

A fourth case may be mentioned because of the strikingly rapid response. The patient had a large solitary syphilitic nodule on the temporal portion of the right iris. Two days after the second treatment there was absolutely no elevation at the site of this nodule, and the eye was no longer injected, painful or photophobic. Injections of neoarsphenamine were started, and the patient returned for weekly

fever treatments after discharge from the hospital. There has been no recurrence of the iritis.

On comparing the results for these patients with those for the patients in the clinic who were not eligible to receive fever therapy because of nonresidency or who declined the treatment, one can note a distinctly shorter course and fewer permanent synechiae in those given fever therapy. The resultant visual acuity was approximately the same for the two groups. Those patients who are seen and treated early respond much more quickly and more completely.

SYPHILITIC ATROPHY OF THE OPTIC NERVE.—Neymann and Osborne ^{36a} reported 6 cases of far advanced atrophy of the optic nerve in which electropyrexia was used. Two of the patients became blind; the condition in 2 was unchanged, and 2 showed improvement. Culler and Simpson ³⁰ were able to demonstrate practically no change in visual acuity or in the visual fields in 14 cases during a period of twenty months' observation.

Menagh ³⁷ reported improvement only in those cases in which cellular infiltration of the nerve was present. According to Culler and Simpson, neuritis as a secondary manifestation of syphilis responded well, and neuritis associated with syphilis of the nervous system was arrested; they reported 4 cases of the former and 10 of the latter. Clark ³⁸ studied 12 cases of syphilitic atrophy of the optic nerve in which malaria therapy was employed; he attributed improvement in 8 of these to fever, vasodilatation and stimulation of the reticuloendothelial system.

Report of a Case of Atrophy of the Optic Nerve.—The patient was seen first in the ophthalmic clinic, where a diagnosis of atrophy of the optic nerve, probably due to tabes, was made. Examination of blood and spinal fluid gave positive results, and the colloidal gold curve was of the tabetic type. The diagnosis was confirmed in the neurologic clinic. The vision in the left eye was 20/30; that in the right eye was limited to perception of light. The pupils were both small and reacted but slightly to light. The left visual field was limited to an irregular angulated central area. The right visual field could not be taken. After six fever treatments no change was noted in the peripheral field, in the serologic reaction of the blood and spinal fluid or in the colloidal gold curve. The patient stated that he no longer has pains in the legs and is perhaps less ataxic. Vision remains the same.

In this case it is assumed that the improvement in the lancinating pains in the legs was due to a subsidence of the radiculitis.

36a. Neymann, C. A., and Osborne, S. L.: The Development of Hyperpyrexia, *Arch. Phys. Therapy* **15**:149 (March) 1934.

37. Menagh, F. R.: Treatment of Syphilis with Hyperpyrexia, with Observations on the Prognosis of Optic Atrophy, *Am. J. Syph., Gonorr. & Ven. Dis.* **21**:609 (Nov.) 1937.

38. Clark, C. P.: Rôle of Malaria in Control of Atrophy of the Optic Nerve Due to Syphilis: A Study of Twelve Cases, *Arch. Ophth.* **15**:250 (Feb.) 1936.

TABLE 3.—Data on Eleven Cases of Syphilitic Iridocyclitis

Patient	Age, Years	Extent of Involvement*	Previous Anti-syphilitic Treatment	Duration of Treatment Prior to Fever Therapy	Posterior Synechiae	Keratite Precipitates	Number of Treatments	Total Hours of Treatment	Vision on Admission	Final Vision†	Reurrence
L. A.	39	O. U.	None	14 days	From 10 to 12; broad and rigid	++	5	17	Hand movements and 20/200	Reading vision in each eye	No
M. B.	24	O. U.	None	6 wk.	From 8 to 10; broad and rigid	++	3	9	20/200 and 20/200	Reading vision in each eye	No
W. U.	24	O. U.	None	4 wk.	From 3 to 5; delicate	+	3	7	20/200 and 20/20	20/20 and 20/20	No
S. M.	26	O. D.	None	8 days	Few; delicate	+	4	17	20/40 and 20/40	20/20 and 20/20	No
J. B.	22	O. U.	4 mo.	14 days	From 8 to 10; broad and rigid	—	4	16	20/20 and 20/65	20/20 and 20/65	No
W. D.	24	O. D.	None	7 days	1; delicate (nodular fritis)	+	2	8	20/200 and 20/30	20/20 and 20/20	No
N. T.	37	O. D.	1 wk.	16 days	3; delicate	+	2	10	20/70 and 20/30	20/20 and 20/30	No
W. B.	31	O. U.	None	1 mo.	8; broad and rigid	+++	10	50	20/200 and 20/200	20/20 and 20/30	No
H. C.	39	O. U.	6 mo. irreg.	2 mo.	From 8 to 10; small but rigid each eye	++	2	4	20/70 and 20/200	20/70 and 20/200	Yes
R. O.	19	O. U.	None	3 wk.	6; narrow	+	7	31	Hand movements in each eye	20/30 and 20/30	No
F. N.	24	O. D.	None	2 wk.	4; broad and rigid	+++	3	13	Hand movements and 20/20	20/70 and 20/20	No

* O. U. indicates each eye; O. D., the right eye, and O. S., the left eye.

† Reading vision is equivalent to about 20/40.

MENINGOVASCULAR SYPHILIS

Reports of several investigators indicate that meningovascular syphilis of the nervous system responds readily to fever therapy, especially when combined with chemotherapy.

Theoretically, during the early stage or during the stage of actual inflammatory reaction in the nerve tissue, this should be the treatment par excellence, when combined with chemotherapy.

The case reported here, in which treatment was incomplete, is included for the sake of completeness of this report and to indicate that good results are anticipated in such cases in the future.

Report of a Case of Meningovascular Syphilis with Paralysis of the Extrinsic Ocular Muscles.—A patient with meningovascular syphilis and paralysis of the extrinsic ocular muscles was treated with heat combined with the administration of neoarsphenamine. Only one treatment had been given, when an infection of the upper part of the respiratory tract developed. The patient has not returned for more fever therapy. She has continued antisyphilitic therapy and improved satisfactorily. Vision is 20/20 in the right eye and 20/40 in the left eye.

No conclusion can be drawn from this case.

MENINGOCOCCIC ABSCESS OF THE VITREOUS

There is a definite theoretic reason for employing fever therapy in cases of meningococcic abscess of the vitreous. The meningococcus is biologically similar to the gonococcus and is known to be susceptible to high temperatures.

Moench³⁹ recently reported the in vitro heat sensitivity of fifteen strains of meningococcus within the range of therapeutic temperatures. At temperatures of from 40 to 42 C. (104 to 107.6 F.) all but one strain showed reduction of growth within from five to seven hours. Five strains were either destroyed or reduced in five hours or less, seven strains showed moderate reduction; two showed only slight reduction, and one was not affected in seven hours at a temperature above 41 C. (105.8 F.). It would therefore seem advantageous to use several five or six hour treatments at from 41 to 42 C. It would also seem best to start treatment at the earliest possible time, depending on the patient's general condition. Meningococcemia and meningitis have also been treated by fever therapy, but not enough data are available to draw any conclusions.

A year ago Dunphy⁴⁰ reviewed the ocular complications of cerebrospinal meningitis in a most thorough manner. Intraocular injection of

39. Moench, L. M.: A Study of the Heat Sensitivity of the Meningococcus in Vitro Within the Range of Therapeutic Temperatures, J. Lab. & Clin. Med. 22:665 (April) 1937.

40. Dunphy, E. B.: Ocular Complications of Cerebrospinal Meningitis, Arch. Ophth. 15:118 (Jan.) 1936.

specific antiserum was advocated. No mention of fever therapy was made for any of the complications described.

Report of Two Cases of Meningococcic Abscess of the Vitreous.—Two patients with endophthalmitis developing as a complication of epidemic meningitis were treated by fever therapy in the division for contagious diseases at the Cincinnati General Hospital. One of the patients had no perception of light in the involved eye. The other had only perception of light. It was not thought possible to recover more vision for these patients. However, because such eyes usually remain irritable, injected, photophobic and blind, with unsightly globes, often progressing to phthisis bulbi, it was decided to try fever therapy in the hope that the inflammatory process would be quieted earlier and perhaps remain so. The first patient had marked iridocyclitis and keratic precipitates, and the conjunctival smear was positive for meningococci. Five treatments, two of five hours and three of three hours' duration, were given. The shorter treatments were given because temperature was not being sustained at a sufficiently high level. The conjunctival smears became negative. The generalized injection of the globe progressively decreased. The hypopyon and keratic precipitates, which had been receding slowly prior to treatment, disappeared rapidly after the first two sessions. The yellow pupillary reflex remained dull until the fourth treatment. Then it became brighter, and the inflammatory reaction on the vitreous seemed to be "fixed." Four months ago it was found advisable to enucleate the phthisical eye.

The second patient had but one treatment before being sent home. She stated that she could open her eye better and had less fear of light while in the fever machine, but that in a few hours it again hurt her to open her eye. No objective change could be noted.

PHLYCTENULAR KERATOCONJUNCTIVITIS

Only one report could be found in the literature on the use of artificial fever⁸ for the treatment of phlyctenular keratoconjunctivitis. Non-specific protein therapy has probably been employed, but is not mentioned in the standard textbooks on ophthalmology.

In the average case the disease responds well to symptomatic local treatment plus a regimen intended to improve the general nutrition. There is, however, a small percentage of cases in which visual acuity is markedly impaired, even to the point of blindness, because of the formation of corneal scars. Many patients have repeated attacks, and in others the condition persists for long periods, during which the patient is entirely incapacitated because of the severe pain and blepharospasm due to ulceration at the site of the phlyctenae.

Subjective relief in cases in which the condition is severe and of long duration and the prevention of marked corneal scarring are the aims of radical treatment.

It is recommended that fever therapy be reserved for use in cases of severe involvement, with the intent of relieving subjective symptoms and preventing permanent visual damage.

Report on Four Cases of Phlyctenular Keratoconjunctivitis.—All 4 cases of phlyctenular keratoconjunctivitis were typical, and in all the patients gave positive

reactions to tuberculin. In 2 there was evidence of involvement of the hilar lymph node on roentgenographic examination. The condition developed in 1 case three months after gonorrheal conjunctivitis, with the residual corneal scarring. The specific conjunctivitis had responded to routine local and systemic treatment. The patient, aged 22 months at the time of heat treatment, was the youngest in the series and tolerated the treatments well.

After treatment with the hypertherm, all 4 patients had marked subjective and less marked objective improvement. However, it was thought that healing was effected sooner than usual. The resultant scars were all small and macular in type. Local treatment consisted of the use of atropine and hot compresses; general treatment consisted of a diet high in calories and vitamins and the administration of cod liver oil.

CORNEAL ULCERS

Whitney⁴¹ reported the successful treatment of corneal ulcers with the Kettering hypertherm. The series of patients at the Cincinnati General Hospital included 2 with corneal ulcer. Reports of these cases follow:

The first patient, a Negro boy aged 12 years, had had purulent dacryocystitis for many months prior to sustaining a corneal abrasion from a foreign body. Ulceration followed the injury. The use of atropine, hot compresses and irrigations with antiseptic solutions failed to alter the course of the ulcer.

Treatments with the hypertherm were started. The ulcer cleared rapidly, and after healing only a small leukoma remained. Eight treatments were given. Final vision was 20/30.

The second patient was treated for a chronically recurring ulcer on the right cornea. One year previously the patient had had a bilateral corneal condition, the nature of which was not known, which left a leukoma on the left cornea. The site of the ulcer on the right cornea was the same as that of the original process. The eyeball showed marked injection of the ciliary body and was irritable. Local treatment had given only partial and temporary improvement.

Three fever treatments were given, and the response was surprisingly good. The ulcer healed rapidly, leaving a smaller scar than had been anticipated. Apparently there has been no recurrence. The patient was followed for three months and then stopped coming to the clinic even for observation. Vision was preserved in this eye (20/30).

At the hospital most of the patients with corneal ulcer have been treated with injections of typhoid vaccine or antigen, sometimes combined with paracentesis. The results have been good, so that only 2 patients have been treated with fever therapy.

CONJUNCTIVITIS DUE TO GRAM-POSITIVE DIPLOCOCCI

One case of conjunctivitis due to gram-positive diplococci is presented.

A child 4 years of age was admitted to the hospital with severe purulent conjunctivitis. The lids were swollen, and the cornea was uninvolved. Smears

41. Whitney, E. L.: Artificial Fever in the Treatment of Corneal Ulcer and Acute Iritis: Preliminary Report, *J. A. M. A.* **104**:1794 (May 16) 1935.

showed gram-positive diplococci. Three seven-hour treatments and one four-hour treatment were given. The conjunctival discharge increased after the first two treatments and then subsided rapidly, the smears becoming negative. When the patient was dismissed from the hospital, the lids, conjunctiva and cornea were normal. Vision was 20/20 in each eye. Unfortunately, the thermal death point of this particular organism was not determined.

ALLERGIC CONJUNCTIVITIS

The series of 50 cases presented here includes 1 case of allergic conjunctivitis.

A Negro boy of 6 years, with severe, resistant allergic conjunctivitis, which had not responded to treatment in the "allergy clinic," was given twenty-three hours of fever therapy. There was no known precedent for this treatment and no apparent reason for using it. Symptomatic relief was not obtained, and no objective improvement resulted from the three treatments. Visual acuity was not altered by the conjunctivitis.

NONSPECIFIC UVEITIS

Two patients with uveitis of unknown origin were treated with heat. A thorough search for all possible causes was made and repeated, without success.

The first patient had two treatments, with only temporary subjective relief. No change could be seen in the amount of injection or in the amount of corneal precipitates or vitreous exudates. The patient had also failed to respond to injections of typhoid antigen given elsewhere and has shown only a slight tendency to improve since the onset six months previously. It is felt that if more fever therapy had been accepted, some improvement might have resulted. The patient is now able to see hand movements at 4 feet (122 cm.).

The second patient had bilateral severe iridocyclitis, which had not responded to various other methods of treatment during the preceding four months. Fever therapy was tried as a last resort. Only temporary subjective relief was obtained after four treatments. No objective improvement was noted. The condition in this case has progressed to practical blindness despite all treatment.

CONJUNCTIVITIS WITH MARGINAL CORNEAL ULCERS

The present series of cases includes 1 of conjunctivitis with a marginal corneal ulcer.

The patient had been treated by several excellent ophthalmologists prior to admission to the clinic. The course of the conjunctivitis had not been determined, despite two thorough examinations. There was no improvement after one session of fever treatment, lasting three hours at a temperature of from 105 to 106 F., and further treatments were refused because a marked herpes labialis developed and because no subjective improvement had been experienced. When mycelia were finally demonstrated on direct smear, instillations of a solution of acriflavin were prescribed, and a remission of two months' duration resulted. Recently a relapse occurred in this case, and a diagnosis of Mooren's ulcer was made elsewhere.

TUBERCULOUS KERATITIS AND IRIDOCYCLITIS

One patient with tuberculous keratitis and iridocyclitis was subjected to fever therapy.

The patient had bilateral persistent keratitis, with diffuse scar formation. Iridocyclitis with secondary glaucoma had developed in one eye. The condition was considered hopeless, but two fever treatments of three and a half hours' duration at from 106 to 108 F. were given; only temporary subjective and no objective improvement occurred in either eye. The inflamed eye was removed because it was blind and painful. Microscopic sections showed primary tuberculosis of the cornea. Two years later the patient returned for enucleation of the second eye, which was then blind and painful. Sections of this eye did not show positive microscopic evidence of tuberculosis.

COMPLICATIONS OF FEVER THERAPY

Not all complications of fever therapy have been observed in the series of cases presented here, but all have been observed at the Cincinnati General Hospital, in the department of fever therapy.

Complications are infrequent and for the most part easily handled. Some of the distressing complications noted earlier in the history of fever therapy have been abolished by careful preparation of the patient with the administration of calcium preparations, saline solution and dextrose and the administration of a minimal amount of sedatives.

The following complications have been observed in this series:

1. Nausea and vomiting. This may be delayed until from one half to one hour after treatment and is best prevented by avoiding the use of morphine and by refraining from overeating and the ingestion of drinks that are too cold.

2. Tetany. This may be avoided by the routine administration of calcium lactate or calcium gluconate and saline solution.

3. Muscle cramps. These may be avoided by the ingestion of saline solution, or by the intravenous injection of it if necessary. Numbness and tingling are not infrequently complained of during periods of induction and decline of fever.

4. Heat exhaustion. The temperature may continue to rise, and the blood pressure continue to drop. (In 1 case it rose to 109 F. in two hours.) If this occurs the patient is removed from the box and rubbed with ice and towels. Saline solution and dextrose are given intravenously. The temperature then drops, and the blood pressure returns to normal after about two hours.

5. Shock—vasomotor collapse without a continued rise in temperature. If this occurs, saline solution and dextrose are given intravenously, and stimulants (coramine [a 25 per cent solution of pyridine beta-carbonic acid diethylamine] or a similar drug) are administered.

TABLE 4.—Data on Group of Fifty Cases of Ocular Disease

Patient	Race	Sex	Age, Years	Diagnosis	Extent of Involvement	No. of Treatments	Total Hours of Treatment	Temperature Range, F.	Subjective Improvement	Objective Improvement	Final Visual Acuity†
A. A.	White	M	20	Gonorrheal conjunctivitis.....	O. S.	3	2½	105-107	Marked	Marked	20/20 and 20/15
J. D.*	Negro	M	6	Gonorrheal conjunctivitis with ulcer....	O. S.	3	16	105-107	Marked	Marked	Reading vision 20/30 and 20/20
R. T.	White	M	53	Gonorrheal conjunctivitis with ulcer....	O. D.	4	5½	105-107	Marked	Marked	20/30 and perception of light
F. T.	White	M	9	Gonorrheal conjunctivitis.....	O. U.	6	19½	103-106	Marked	Marked	20/30 and 20/30
J. L.	Negro	M	22	Gonorrheal conjunctivitis with ulcer....	O. S.	5	15	105-106	Marked	Marked	20/30 and 20/30
G. F.	Negro	M	9	Gonorrheal conjunctivitis.....	O. S.	2	11	105-108	Marked	Marked	20/30 and 20/30
B. W.	Negro	F	4	Gonorrheal conjunctivitis.....	O. U.	2	6	105-106	Marked	Marked	20/20 and 20/20
M. B.	Negro	F	9	Gonorrheal conjunctivitis with ulcer....	O. S.	2	9½	105-106	Marked	Marked	20/20 and 20/20
P. H.	White	M	22	Gonorrheal conjunctivitis; perforation.	O. U.	9	38	105-107	Marked	Good; slow	20/20 and perception of light
R. J.	Negro	F	4	Gonorrheal conjunctivitis.....	O. D.	1	5	106-107	Marked	Good; burned	20/20 and 20/20
W. O.	White	M	13	Gonorrheal conjunctivitis.....	O. U.	2	6	104-107	Marked	Marked	20/20 and 20/20
E. P.	White	M	25	Gonorrheal iridocyclitis.....	O. S.	3	13	105-106	Marked	Marked	20/20 and 20/20
L. J.	White	F	10	Interstitial keratitis.....	O. U.	6	28	105-106	Marked	Marked	Reading vision in each eye
M. W.	White	F	10	Interstitial keratitis.....	O. D.	3	11½	105-106	Marked	Marked	20/40 and 20/30
G. C.	White	F	12	Interstitial keratitis.....	O. U.	12	47	103-106	Marked	Slight	20/50 and 20/50
E. A.	White	M	5	Interstitial keratitis.....	O. S.	9	27	105-107	Marked	Marked	Reading vision in each eye
L. T.*	Negro	F	9	Interstitial keratitis.....	O. U.	11	37½	105-107	Marked	Marked	20/50 and 20/65
L. J.	White	M	8	Interstitial keratitis.....	O. U.	6	12	103-106	Marked	Marked	20/20 and 20/20
El. W.	Negro	F	9	Interstitial keratitis.....	O. U.	13	48	103-107	Marked	Marked	20/20 and 20/40
M. J.	Negro	F	12	Interstitial keratitis.....	O. S.	8	32	103-106	Marked	Marked	20/20 and 20/20
En. W.	Negro	F	12	Interstitial keratitis.....	O. S.	6	23	105-106	Marked	Moderate	20/20 and 20/20
J. E.	Negro	M	9	Interstitial keratitis.....	O. D.	4	20	105-106	Marked	Slight	20/25 and 20/25
L. A.	White	M	39	Syphilitic iridocyclitis.....	O. U.	5	17	104-106	Marked	Moderate	Reading vision and 20/30
M. B.	White	F	24	Syphilitic iridocyclitis.....	O. U.	3	9	105-106	Marked	Moderate	Reading vision in each eye
S. O.	Negro	M	24	Syphilitic iridocyclitis.....	O. D.	3	7	103-106	Marked	Marked	20/20 and 20/20
W. M.	Negro	F	26	Syphilitic iridocyclitis.....	O. D.	4	17	103-106	Marked	Marked	20/40 and 20/40
J. B.	Negro	M	22	Syphilitic iridocyclitis.....	O. U.	4	16½	105-107	Slight	Fair	20/20 and 20/65
W. D.	Negro	F	24	Syphilitic iridocyclitis.....	O. U.	4	10	105-106	Marked	Marked	20/20 and 20/20
N. T.	White	F	37	Syphilitic iridocyclitis.....	O. D.	4	10	105-106	Marked	Marked	20/20 and 20/30
W. B.	White	M	31	Syphilitic iridocyclitis.....	O. D.	2	50	103-106	Marked	Moderate	20/30 and 20/30
H. O.	Negro	F	39	Syphilitic iridocyclitis.....	O. U.	2	4	103-107	Temporary	None	20/40 and 20/40
R. C.	Negro	M	19	Syphilitic iridocyclitis.....	O. U.	7	31	103-106	Moderate	Slow	20/30 and 20/30
F. N.	Negro	F	24	Syphilitic iridocyclitis.....	O. D.	3	13½	103-106	Marked	Moderate	Reading vision and 20/20
C. B.	White	M	24	Syphilitic iridocyclitis.....	O. U.	12	50	104-106	None	None	Perception of light and 20/30
P. E.	Negro	F	26	Meningovascular syphilis with paralysis of ocular muscles	O. S.	1	5	105-106	None	None	20/20 and 20/40
D. E.	White	F	7	Abscess of vitreous (meningoceles).....	O. D.	6	18	103-107	Moderate	Slight	No vision and 20/20
N. H.	White	F	11	Abscess of vitreous (meningoceles).....	O. D.	1	3	105-106	Temporary	None	Perception of light and 20/20
B. D.*	Negro	F	5	Phlyctenular keratoconjunctivitis.....	O. U.	3	25	105-107	Marked	None	Reading vision in each eye
E. P.*	Negro	F	2	Phlyctenular keratoconjunctivitis.....	O. U.	8	36	103-107	Marked	Moderate	Reading vision in each eye
P. P.*	White	M	13	Phlyctenular keratoconjunctivitis.....	O. D.	3	16	101-106	Marked	Marked	20/25 and 20/25
L. S.	Negro	M	7	Phlyctenular keratoconjunctivitis.....	O. U.	2	6	104-106	Marked	Marked	20/20 and 20/20
O. H.	Negro	M	9	Tuberculous parenchymatous keratitis.....	O. S.	7	23	103-106	Marked	Marked	20/25 and 20/25
C. W.	White	M	11	Cornual ulcer.....	O. S.	2	8	105-106	Marked	Marked	Reading vision in each eye
E. S.	Negro	M	12	Cornual ulcer.....	O. D.	2	8	105-106	Marked	Marked	20/30 and 20/20
J. H.	Negro	M	4	Pneumococcal conjunctivitis.....	O. D.	6	25	104-107	Marked	Marked	20/20 and 20/20
L. D.	Negro	M	4	Allergic conjunctivitis.....	O. S.	4	26	106-107	Marked	Marked	20/30 and 20/30
J. F.	White	M	6	Allergic conjunctivitis.....	O. U.	3	24	104-105	None	None	20/20 and 20/20
J. F.	White	M	26	Nonspecific uveitis.....	O. S.	2	8	105-107	Temporary	None	20/20 and counting of fingers at 2 feet
B. S.	Negro	F	40	Nonspecific uveitis.....	O. U.	4	16	105-106	Temporary	None	No vision and perception of light
S. W.	Negro	M	34	Conjunctivitis, with marginal corneal ulcer	O. U.	1	3	105-106	Temporary	None	20/50 and 20/20
A. S.*	White	F	30	Tuberculous keratitis and iridocyclitis..	O. U.	2	7	106-108	Temporary	None	No vision in either eye

* The patients whose initials are thus indicated were treated by Dr. R. H. Miller and by Dr. M. H. Metz prior to my participation in this field. They have permitted me to include the same case reports in this series.

† O. U. indicates each eye; O. D., the right eye, and O. S., the left eye.

‡ Reading vision is equivalent to about 20/40. The patients whose final visual acuity is listed as reading vision did not return for refraction, but they could read fine print before discharge.

6. Hysteria and delirium. These complications are noted most frequently in patients with gonorrheal arthritis for some unknown reason. Their occurrence is not serious.

7. Burns. Patients are covered with blankets in the box to prevent their being burned. Occasionally skin over bony prominences not in contact with anything becomes burned. In a Negro girl aged 4 years, a burned area developed on the skin covering a large umbilical hernia. Healing was normal in rate.

8. Collapse. This is seen more frequently in cases of congenital syphilis, but it is not serious, lasting only a few minutes. The patient becomes pale; the pulse becomes weak, and the blood pressure falls. In no case has it been severe enough to necessitate stopping all treatment. Failure to induce the desired temperature is sometimes encountered. A given patient may fail to get a consistent rise in temperature at one session and react perfectly the next. No reason for this is known. It has also been noted that fever is harder to attain and maintain in the Negro and in the patient who have worked for long periods in extremely hot places.

COMMENT

The treatment in the present series of cases has been administered on the theory that the more acute the ocular inflammation, the more frequent should be the fever treatments. This plan seems to have served well in this limited number of cases. Treatments were given every third day, if possible, depending on the patient's general condition and reaction. Five-hour sessions with temperature maintained from at 105 to 107 F. were found to be most satisfactory. Maintaining the same temperature for only one hour, even though repeated every day or every other day, proved to be of little value.

There has been no fixed standard for the total number of treatments. The patients were treated as frequently as possible, and treatments were continued until improvement occurred, or until it was felt that the patient was refractile to the treatment. A few patients have returned each week for from four to six weeks after discharge from the hospital for supplementary treatments after the acute inflammatory symptoms had subsided.

It is believed that more frequent treatments are advantageous and that an elastic standard of the total hours of fever to be induced must be maintained, in order to meet the need of each individual case without subjecting the patient to more fever than is necessary. However, I believe that some minimum number of hours could and should be set for the acute and more or less chronic stages of each of the ocular diseases treated. This is most feasible in the various stages of syphilis. Chronic lesions may well be treated once a week for ten or more treat-

ments, as had been done by other investigators. The establishment of a standard procedure will require the consideration of large numbers of cases as reported by different observers who use both identical and different intervals and total fever hours of treatment. When the thermal death point of the causative agent is known, the dosage is easier to estimate, but the clinical course must determine the management in each individual case.

Some opposition is often encountered when fever therapy is suggested to the patient. However, after one session little difficulty is had in getting the patient to continue. Fear of the machine and of the fever are dispelled, and subjective relief in acutely inflamed eyes with photophobia, blepharospasm, pain and excessive lacrimation is usually noticeable after the first or second treatment.

The *modus operandi* of fever therapy is as yet unexplained. "Stimulation of body defense mechanism" is a vague and indefinite term. No better explanation is offered for the action of injected nonspecific protein and malaria. Numerous comparative studies have appeared in the literature advocating one or another method in preference to other fever-producing agents. Such studies are of great value in determining relative merits. The method is being sought which produces the best end result with the least damage to the patient and which is most easily employed.

Although this paper is a report of observations made on patients treated in the Kettering hypertherm only, a few comparisons have been made with results observed or claims made by others using injections of nonspecific proteins and of malarial organisms.

One cannot help feeling that perhaps both of the latter forms of treatment may add to, or cause to be produced in, the body something more than an elevation of body temperature. This feeling is accentuated by the observation that injections of nonreactive typhoid antigen often give excellent therapeutic results and by reports that patients inoculated with malarial parasites who do not get chills and fever are improved (patients with dementia paralytica). For these reasons one must not allow oneself to become too enthusiastic over mechanically induced hyperpyrexia. It remains for those interested in this form of therapy to report their few cases accurately until reports of a sufficient number of cases are collected for comparison of the results with the various methods of treatment.

I would suggest the possibility that protein substances may be liberated in the course of any fever, regardless of its origin, which produce a reaction in the body similar to that produced by injected nonspecific proteins.

DISADVANTAGES OF THERAPY WITH THE KETTERING HYPERTHERM

The following disadvantages have been observed from the use of the Kettering hypertherm:

1. The treatment is definitely strenuous. While complications are few and mortality low, this treatment is not unattended by fear, fatigue and some danger of collapse and heat stroke.
2. Constant nursing care is absolutely necessary while the patient is in the fever machine. One nurse is required for each patient, whereas in a ward one nurse can care for many patients being treated by injections of foreign protein or of malarial parasites.
3. The machine itself is expensive, and the cost of operation is fairly high.
4. Fever machines are not accessible to many practicing physicians. This is as it should be until this form of treatment is out of the experimental stage. However, other fever-producing agents are accessible to almost every one.

ADVANTAGES OF THERAPY WITH THE KETTERING HYPERTHERM

The Kettering hypertherm offers the following advantages:

1. High temperatures are readily attained and maintained for definite lengths of time, as desired.
2. The temperature is easily controlled.
3. No new disease is added to the patient as opposed to malaria therapy.
4. The morbidity and mortality are less with fever therapy than with malaria.
5. Hospitalization is often not necessary. A patient can be treated as an outpatient, or at most kept overnight after a treatment. Malaria therapy requires much care during the induced disease and some care during convalescence.
6. The action of heat therapy is rapid. Response is quickly seen and I believe that failure to obtain a response can be told after a few treatments. Treatments can be given three times a week in acute processes and weekly in more chronic diseases.
7. Subjective relief is obtained early and consistently in cases of acute ocular inflammation and in some cases of subacute ocular inflammation (especially interstitial keratitis and iridocyclitis). Relief of photophobia and blepharospasm allows better examination and local treatment of the involved eye.
8. Any other treatment, local or general, directed toward ocular or systemic disease may be given concurrently. Antisyphilitic therapy is considered more effective when combined with fever therapy than

when used alone. When malaria therapy is used antisyphilitic treatment must be discontinued lest it kill the fever-producing organism. Typhoid and other nonspecific proteins can be injected between fever treatments. This serves to satisfy those who feel that the body's defense mechanism is better stimulated in this way.

SUMMARY AND CONCLUSIONS

The Kettering hypertherm is a valuable agent for the treatment of several ocular diseases.

It is most efficacious in the treatment of gonorrheal conjunctivitis, syphilitic interstitial keratitis and syphilitic iridocyclitis.

Much more investigation is necessary before definite conclusions can be drawn concerning its relative value, its indications and the number and frequency of necessary treatments.

It is suggested that persons with acute active inflammations and gonorrheal conjunctivitis be treated as frequently as they can tolerate hyperpyrexia. Less frequent treatments may be used for those with more chronic conditions.

It is suggested that corneal ulcer, severe phlyctenular keratoconjunctivitis, metastatic meningococcic endophthalmitis and active neuritis of the optic nerve (especially of the syphilitic type) be given more study to determine the value of fever therapy for these conditions.

441 Vine Street.

Correspondence

INSTRUMENTS FOR TREATMENT OF STRABISMUS

To the Editor:—In the December 1937 issue of the ARCHIVES the surgical treatment of strabismus is reviewed by Dr. Maynard C. Wheeler of New York. On page 1005 Dr. Wheeler states: "One of the newer and more original contributions to the surgical treatment of strabismus is the method for shortening a muscle by means of the myocampter, perfected by Barraquer."

I have never seen Barraquer's myocampter, but Dr. Wheeler's description of the instruments and the procedure is almost identical with that of the instruments and procedure of the late Dr. H. H. Briggs, of Asheville, N. C.

In the *Transactions of the Section on Ophthalmology of the American Medical Association* for 1909 and again in a paper read at the New York meeting of the American Medical Association in June 1917 and published in the *Transactions* of that year (pages 260-270), Dr. Briggs described his method of tendon shortening by the use of the silver clip. The instruments for this procedure have been on sale by Meyrowitz for more than twenty years.

Dr. Wheeler's review of the literature does not go back farther than 1930. In justice to American ophthalmologists, however, I feel that Barraquer's myocampter should not be called "one of the newer contributions," and it is doubtful in my mind whether it should be called "original."

This letter is not intended in any degree as a reflection on or as a criticism of Dr. Wheeler's review. His article reviews only the recent literature and is, in my judgment, one of the best that I have seen on the surgical treatment of strabismus.

WALTER J. BRISTOW, M.D., Columbia, S. C.

OCULAR MANIFESTATIONS OF ENDOCRINE DISTURBANCE

Dear Dr. Lemoine:—I enjoyed reading your article on "Ocular Manifestations of Endocrine Disturbance" in the ARCHIVES OF OPHTHALMOLOGY (19:184 [Feb.] 1938).

I should appreciate an explanation of your statement (page 188) that calcium disturbance may produce cataract.

How does an increase or decrease of calcium in the blood affect the transparency of the lens? As a matter of fact, the chemistry of the lens remains the same at all ages until opacification sets in.

Your statement that there is a close association between cataract and parathyroid tetany, while true, requires a rational explanation. It is not the mystic hormonal activity of the parathyroid gland that causes cataract in some cases of parathyroid tetany but the direct injury to the lens due to a concussion of the lens during the convulsion. The

same is true of epileptic and eclamptic convulsions, which are associated with a higher incidence of cataract formation.

No convulsion, no cataract. Not the calcium but the concussion causes the cataractous formation.

AARON BRAV, M.D., Philadelphia.

Dear Doctor Brav:—Your point is well taken, as there is no definite chemical evidence that calcium disturbance plays a part in altering the calcium content of the lens. That was the reason for qualifying the statement with the word "may." However, one must bear in mind that many problems of nutrition and biochemical processes are not yet fully understood or explained and that by altering the nutrition and intraocular chemistry cataract could develop without altering the calcium content of the lens. The incidence of calcium deficiency in juvenile and presenile patients with cataract but no family history of the condition is too frequent for its occurrence to be entirely a coincidence. Consequently, I concluded that calcium deficiency may produce cataract.

ALBERT N. LEMOINE, M.D., Kansas City, Mo.

News and Notes

EDITED BY W. L. BENEDICT

SOCIETY NEWS

Ophthalmological Society of the United Kingdom.—The annual congress of the Ophthalmological Society of the United Kingdom was held at the headquarters of the Royal Society of Medicine, 1 Wimpole Street, London, W. 1 on April 28 to 30, 1938, Dr. Gordon M. Holmes, C. M. G., C. B. E., F. R. S., presiding.

The program opened with a discussion on the differential diagnosis of the causes of exophthalmos. Contributors to this discussion were as follows: Mr. R. Foster Moore (ophthalmic aspects), Mr. T. Cawthorne (otolaryngologic aspects), Dr. Russell Brain (medical and neurologic aspects), Mr. J. H. Doggart (differential diagnosis in children) and Mr. Pochin (lid retraction and exophthalmos in exophthalmic goiter). The following papers were presented:

"A Case of Glioma Retinae, with Special Reference to the Mode of Spread." Mr. S. Spence Meighan and Mr. I. C. Michaelson.

"A Case of Meningocele of the Orbit and the Diagnosis from Other Cystic Tumors." Mr. M. H. Whiting.

"Remarks on Ophthalmic Gout." Mr. L. H. Savin.

"A Contribution to the Pathology of Angioid Streaks." Mr. F. W. Law.

"Abnormal Retinal Correspondence." Miss Cass.

"Some Aspects of the Anatomy of the Optic Nerve Head." Mr. E. Wolff.

"The History of Contact Lenses." Miss Ida Mann.

"Some Observations on Fluid Interchange and Its Bearing on Certain Ophthalmologic Problems." Dr. Douglas Robertson.

"The Osmotic Pressure Equilibrium in Normal and Glaucomatous Eyes." Dr. T. H. Hodgson.

"Detachment of the Choroid." Mr. B. W. Rycroft.

"Vascular Changes in the Retina, Optic Nerve and Kidney: A Clinical and Pathologic Study. Prof. A. J. Ballantyne, Mr. I. C. Michaelson and Mr. J. F. Heggie.

"Associated Lacrimal and Parotid Mixed Tumors." Messrs. J. Pendleton White, I. C. Michaelson and J. F. Heggie.

"Observations on the Treatment of Epiphora." Mr. O. Gayer Morgan.

"A Further Communication on the Etiology and Treatment of Phlyctenular Ophthalmia." Mr. A. Sorsby, Mr. R. Hamburger, Miss Margaret Coveney and Miss Mary E. Nevin.

"Ophthalmic Operations under Evipan." Mr. T. K. Lyle.

"Paraldehyde Analgesia." Dr. E. S. Rowbotham.

"A Series of Operations Under Paraldehyde Narcosis." Mr. Basil Graves.

"Some Problems of Neuromyelitis Optica." Dr. T. R. Hill.

"Direct Measurement of the Axial Length of the Eye in the Living Subject by X-ray." Mr. R. H. Rushton.

"A Melanosome Dispersing Substance in the Blood and Urine in Retinitis Pigmentosa." Dr. E. C. Dax.

"Retinitis Pigmentosa in Rats." Miss D. R. Campbell.

"Notes on Dark Adaptation and a Simple Instrument for Its Investigation." Mr. R. P. M. Haines.

"The Treatment of Tobacco Amblyopia by Acetylcholine." Mr. P. M. Moffatt.

Oxford Ophthalmological Congress.—The twenty-seventh annual meeting of the Oxford Ophthalmological Congress will be held at Keble College, Oxford, on the evening of Wednesday, July 6, and the meetings will be held on the following Thursday, Friday and Saturday, July 7, 8 and 9.

On Thursday morning, July 7, there will be a discussion on "Ocular Palsies, Their Etiology, Diagnosis and Treatment." The discussion will be opened by Dr. Bernard Chavasse, Liverpool, from the ophthalmologic point of view, and by a neurologist.

The Doyne Memorial Lecture will be delivered by Prof. Dr. A. von Szily, emeritus director of the Univ-Augenklinic, Münster, and will be entitled "The Contribution of Pathologic Examinations to the Elucidation of the Problems of Cataract—Morphologic Findings and Changes in the Chemistry of the Lens in Different Cases of Cataract, Their Primary Role, Temporal Sequence and Local Combination."

In addition to the foregoing program, the following papers have already been promised:

"The Relationship Between Intracranial and Intraocular Pressure, and the Treatment of Tabetic Optic Atrophy." Prof. Dr. Hans Lauber, Warsaw, Poland.

Discussion on "Anesthesia in Ophthalmic Surgery," opened by Dr. H. M. Traquair, Edinburgh, Scotland.

"Anatomic Changes in Globes with Primary Detachment of the Retina." Dr. Bernard Samuels, New York.

"Papilledema." Dr. J. A. van Heuven, Utrecht, Netherlands.

"Hungarian Plastic Methods." Dr. Czukrasz Ida, Debrecen, Hungary.

Graduate Meeting in Ophthalmology.—This meeting was held at the Wilmer Ophthalmological Institute of the Johns Hopkins Hospital, May 12 to 14, 1938. The following program was presented:

"The Clinical Problem of Sympathetic Ophthalmia." Dr. Alan C. Woods.

"The Pathology of Sympathetic Ophthalmia and Cutaneous Allergy to Uveal Pigment." Dr. Jonas S. Friedenwald.

"Retinal Tumors." Dr. John M. McLean.

"Exhibition of Moving Pictures of Eye Operations." Dr. R. Townley Paton.

"Exophthalmos and Orbital Tumors." Dr. M. Elliott Randolph.

"Hyperthyroidism and Exophthalmos." Dr. Henry M. Thomas.

"The Surgical Treatment of Exophthalmos and Orbital Tumors." Dr. Walter E. Dandy.

"Slit Lamp Ophthalmoscopy." Dr. Jonas S. Friedenwald.

"Syphilitic Atrophy of the Optic Nerves: Occurrence, Significance and Treatment." Dr. Joseph Earle Moore.

"Visual Field Changes in Syphilitic Optic Atrophy." Dr. Louise L. Sloan.

"The Classification and Etiology of Cataracts." Dr. Clyde A. Clapp.

"The Comparison of the Results of Intracapsular and Extracapsular Cataract Operations." Dr. Angus L. MacLean.

"Ocular Changes in Neurologic Disease." Dr. Frank B. Walsh.

"Demyelinating Disease." Dr. Frank R. Ford.

"Corneal Dystrophies." Dr. Benjamin Rones.

"Clinical Pathologic Conference." Dr. Jonas S. Friedenwald.

"Ocular and Cutaneous Sensitivity in Ocular Tuberculosis." Dr. Alan C. Woods.

"Recent Advances in Bacteriology and Immunology." Dr. Earl L. Burky.

"Arteriosclerosis." Dr. James Bordley, III.

"Arteriosclerotic Changes in the Fundus." Dr. Jonas S. Friedenwald.

"Lindau's Disease." Dr. Tullos O. Coston.

Philadelphia County Medical Society, Eye Section.—The scientific meeting of the Eye Section of the Philadelphia County Medical Society was held April 7, 1938, at the Philadelphia County Medical Building, Twenty-First and Spruce streets. There was a postgraduate conference in ophthalmology from 7:25 to 8:30 p. m., at which the following papers were presented: "Anatomy and Pathology of the Lacrimal Apparatus," by Dr. Edmund B. Spaeth; "Medical Ophthalmology," by Dr. Wilfred E. Fry, and "Refraction Findings and Effective Glasses," by Dr. Sidney L. Olsho.

At the conclusion of the postgraduate conference a general program was held, at which the following papers were read: "Clinical Case from Wills Hospital" by Dr. J. V. D. Quereau, with Dr. Aaron Barlow as commentator; "Sulfanilamide in Gonorrheal Ophthalmia," by Dr. Harry S. Weaver Jr.; "Clinical Experiences with Sulfanilamide," by Dr. Carroll R. Mullen, and "O'Connor Cinch Operation Simplified" (a colored motion picture), by Dr. M. E. Smukler, with Dr. L. F. Appelman as commentator.

Association for Research in Ophthalmology.—The annual meeting of the Association for Research in Ophthalmology will be held in San Francisco on June 14, 1938. The program follows:

1. "Treatment of Experimentally Produced Exophthalmos with Thyroxin and Other Iodine Compounds." George K. Smelser, Ph.D., New York.

2. "Experimental Studies of the Pathogenicity of Staphylococcus Toxin." Dr. James H. Allen and Dr. A. E. Braley, Iowa City.

3. "Eye Lesions in Experimental Infections with Special Reference to Arthritis." Dr. Conrad Berens, Dr. D. Murray Angevine, Dr. Loren Guy and Dr. Sidney Rothbard, New York.

4. "Studies on the Ocular Fluids; II. The Hexosamine Content." Dr. Karl Meyer, New York.

5. "The Influence of the Central Nervous System on the Pigment Migration in the Retina of the Frog." Dr. H. Burian, Hanover, N. H.

6. "Inclusion Blepharitis; A Study of the Pathologic Changes in the Conjunctiva and Cervix." Dr. A. E. Braley, Iowa City.

7. "Influence of Dinitrophenol on the Production of Experimental Cataracts by Lactose." Dr. W. E. Borley and Dr. M. L. Tainter, San Francisco.

8. "Glaucoma: Classification, Causes and Surgical Control (Results of Microgonioscopic Research)." Dr. Otto Barkan, San Francisco.

Colorado Ophthalmological and Otolaryngological Societies.—The sixteenth annual summer graduate course in ophthalmology and otolaryngology, under the auspices of the Colorado Ophthalmological Society and the Colorado Otolaryngological Society, will be given in Denver, July 25 to Aug. 6, 1938. The following guest speakers will participate: in ophthalmology, Dr. Alfred Cowan, of Philadelphia, and Dr. Edwin M. Neher, of Salt Lake City; in otolaryngology, Dr. Oscar V. Batson, of Philadelphia, Dr. Henry B. Orton, of Newark, and Dr. Earl C. Padgett, of Kansas City, Mo.

GENERAL NEWS

Summer Course in Ophthalmology and Otolaryngology.—The thirteenth intensive European summer course in ophthalmology and otolaryngology, under the direction of Dr. George W. Mackenzie, of Philadelphia, will be given in Vienna, Austria, in July. Study in Vienna from July 4 to July 31 will be preceded and followed by a few days of sightseeing in Italy.

Abstracts from Current Literature

EDITED BY DR. WILLIAM ZENTMAYER

Cornea and Sclera

CYCLIC OCCURRENCE OF CHRONIC EDEMA OF THE CORNEA: REPORT OF A CASE. E. E. BLAAUW, *Klin. Monatsbl. f. Augenh.* 98:665 (May) 1937.

Blaauw reports a case resembling that reported by V. Haemmerli (*Klin Monatsbl. f. Augenh.* 97:745 [Dec.] 1936). Blaauw's patient complained of indistinct vision accompanied by colored rings appearing around lights, which he observed after arising and during dressing. These phenomena began disappearing about 2 o'clock in the afternoon, and vision was normal in the evening. The condition lasted for one-half year, with varying intensity and duration. No symptoms of glaucoma were noted during a period of observation of one and one-half year, and vision remained normal most of this time. Tonometric tests were omitted after a minute vacuolization was observed with the slit lamp in the epithelium and in the parenchyma of the cornea. About eight months later the patient returned. His eye was irritated, since he had shoveled snow that morning. Vesicles in the epithelium of the cornea were visible, which changed in size and location in the course of treatment. Repeated bursting of vesicles prompted Blaauw to scrape off the loose epithelium. It came off readily and regenerated slowly, the process resembling the course of acute herpes zoster; the eye was painful, and the lids became edematous at times. Treatment with pontocaine and acetylsalicylic acid, and instillation of cod liver oil later, furthered recovery. The cause of the disease was an infection with the virus of herpes, in Blaauw's opinion.

K. L. STOLL.

General Pathology

A VESSEL-CARRYING LAYER OF CONNECTIVE TISSUE BETWEEN THE PIGMENT EPITHELIUM AND THE LAMINA VITREA. W. REICHLING and F. KLEMENS, *Arch. f. Ophth.* 137:515 (Oct.) 1937.

In supposedly normal eyes removed at autopsy from patients over 50 years of age at the time of death, the authors found a thin layer of vascularized connective tissue situated between the pigment epithelium and the lamina vitrea and extending from the ora serrata to the equator. The origin of the vessels of this layer could not be determined. The layer itself is assumed to be derived from the subepithelial basal substance through a process of histolysis.

P. C. KRONFELD.

Glaucoma

SOME UNUSUAL CASES OF GLAUCOMA SECONDARY TO INJURY. R. A. GREEVES, *Brit. M. J.* 2: 1107 (Dec. 4) 1937.

Greeves reports 4 cases of glaucoma following injury in which no mechanical explanation for the rise in tension was apparent.

CASE 1.—A man aged 21 was struck in the left eye by a football lace. Some time later he complained of attacks of pain, misty vision and haloes. The tension was found to be elevated during the attacks, and the eye was myopic. A solution of 0.25 per cent physostigmine salicylate controlled the attacks.

Two days after trephination examination showed papilledema of 6 diopters and numerous retinal hemorrhages, both of which disappeared within two months. The final vision was 6/4; the field was constricted nasally, and the peripheral retinal arteries were reduced in size. The tension has remained normal for ten years, although the trephine opening closed.

CASE 2.—A man aged 30 received a blow on the eye twenty-two years before the present examination. Fourteen years later he began to have attacks of pain and see haloes. At the present examination the disk was found deeply cupped, and there were an area of pigmentation below the macula and a large iridodialysis in the lower segment. The nasal field was contracted. No treatment had been instituted up to the time the case was reported.

CASE 3.—A man aged 50 had failing vision in the right eye for seven months. There was evidence of a perforating injury in the cornea, iris and lens. The tension was elevated, and the disk was cupped. A roentgenogram revealed an intra-ocular foreign body close to the ora serrata. After this was removed with the giant magnet, the tension fell to normal and was not affected by the administration of homatropine. There was no siderosis.

CASE 4.—A chauffeur had attacks of pain and misty vision in the left eye. He thought that a piece of china had entered the eye several months before. The tension was elevated, the disk was cupped and the vision was reduced to counting fingers at 1 meter. The anterior segment showed signs of a penetrating injury, and a roentgenogram revealed a foreign body in the vitreous. This proved to be nonmagnetic. Trephining successfully reduced the tension to normal.

Greeves thinks that the drainage channels were not altered in the first 2 cases. In the third case removal of the foreign body cured the glaucoma, while in the fourth case trephining kept the tension normal.

W. F. DUGGAN.

THE INFLUENCE OF MARCONITHERAPY (SHORT WAVE) ON PRIMARY GLAUCOMA. M. CORRADO, *Ann. di ottal. e clin. ocul.* 65: 401 (June) 1937.

Twenty patients with primary glaucoma were given treatments with the ultratherm, an apparatus employing a 6 meter wavelength, with setting of the voltmeter between 18 and 21. The Schliephake electrodes were used, the indifferent one (130 mm.) on the neck and the active

one (40 mm.) a few centimeters before the eye. The duration of the treatment was, as a rule, thirty minutes. The tension was recorded several times a day for a period before the treatment and every hour for from one to one and a half days after treatment. Miotics were not administered during the period of observation. The cases of primary glaucoma included both the simple and the inflammatory type, and a number of patients had been operated on by iridectomy or by sclerectomy-iridectomy.

In all cases relief from pain followed the treatment, regardless of whether the tension was reduced. The tension was markedly diminished in 7 of the 20 cases and moderately diminished in 6. It was not affected in the remainder. Among those patients who showed a marked reduction in tension was 1 with chronic glaucoma with an acute exacerbation (tension reduced from 39 to 19 mm.), 3 with chronic inflammatory glaucoma and 3 with simple glaucoma. One patient who was previously operated on with success showed a further reduction of tension after treatment. With relation to the number of patients treated, a marked reduction of tension occurred more often in those with chronic irritative glaucoma than in those with simple glaucoma and more often when tension was only moderately increased. The fall of tension began, as a rule, within from one to two hours after treatment and reached its maximum after from six to nine hours. The favorable effect on tension was secured either after the first treatment or in some cases after succeeding treatments. The tension returned gradually to the preceding level in all except 1 case, in which there was an acute exacerbation of chronic glaucoma. A temporary increase in vision, sometimes fairly marked, was seen in 8 cases, while the visual field showed an increase in only 2. The effect of treatment is attributed chiefly to the active vasodilation produced by the treatment, although other effects, such as an electrochemical change in the tissues, especially the vitreous, is also considered possible.

S. R. GIFFORD.

Lens

UNRECOGNIZED SYPHILIS IN ASSOCIATION WITH SENILE CATARACT.
E. PUSCARIU, *Ann. d'ocul.* 174: 596 (Sept.) 1937.

In 1927 Puscariu reported on the frequency of unapparent syphilis in cases of senile cataract. The article included the results of a study of 809 cases of cataract in which operation was performed.

Since that time there have appeared in different countries a number of articles on this question. In continuing this study, Puscariu found latent syphilis in 14.1 per cent of the cases of senile cataract. Late postoperative iritis appeared in 19 per cent of the cases in which the serum gave a positive reaction to the Bordet-Wassermann test. These represented 40 per cent of the total number of cases of postoperative iritis. Late iritis was rarely found in patients (3.74 per cent) whose serum gave a negative reaction to the test.

Puscariu reviews the different cases reported and emphasizes the likelihood of a parenchymatous keratitis appearing in syphilitic persons after trauma. A bibliography is included.

S. H. MCKEE.

Methods of Examination

STENOPEIC SPECTACLES. A. L. YOUNG, *Brit. J. Ophth.* 22: 45 (Jan.) 1938.

In order to obtain a variable distance between the stenopeic openings in disks placed before the eyes, Young has devised a type of spectacles in which two disks back to back can be rotated independently of each other. Each disk is perforated by a curved slit, 2 mm. in width, the aperture being produced by the overlapping of the slits. By a suitable maneuver it is possible to place the aperture in any position on the disk save in the exact center, and this may be overcome by decentering an equal amount in each disk. Thus a vertical as well as a horizontal correction may be made.

A photograph of the spectacles accompanies the article.

W. ZENTMAYER.

Neurology

OCULAR SYMPTOMS IN CASES OF OLFACTORY MENINGIOMA. E. HARTMANN, M. DAVID and P. DESVIGNES, *Ann. d'ocul.* 174: 505 (Aug.) 1937.

This article is based on the study of sixteen patients with meningioma of the olfactory groove in the service of Clovis Vincent, who were all examined and followed. In all the cases the diagnosis was verified by means of microscopic examination. In Vincent's service the cases of meningioma of the olfactory groove represented about 13 per cent of the total number of cases of meningioma. Ocular disturbances form one of the most important symptoms of meningioma of the olfactory groove. Their presence was noted in each of these sixteen cases. They may be divided into: (1) alterations in the fundus of the eye, such as bilateral papillary stasis (eight cases); primary bilateral atrophy of the optic nerve (three cases), and papillary stasis of one eye, with edema of the edges, associated with papillary discoloration of the other eye (two cases). The fundus was normal in one case. The syndrome of Foster Kennedy was not noted in any case, but in two cases a variation of this syndrome was observed.

Part II takes up visual acuity, which is subdivided into: decrease of visual acuity without ophthalmoscope lesions; visual acuity and papillary stasis, and visual acuity in the syndrome of Kennedy. Then is discussed in order, in part III, the visual field; in part IV, exophthalmos; in part V, the pupillary reaction; in part VI, the corneal sensibility, and in part VII, the motility of the globe.

The authors then take up the postoperative evolution of ocular symptoms. In discussing the diagnosis they state that the ocular symptoms just described may be observed in the course of other disorders, particularly in certain types of meningioma of the small wing of the sphenoid, tuberculous meningioma of the sella, tumor of the hypophysis, glioma of the chiasma and ventricular distention. A table giving the protocols of the sixteen patients is included.

S. H. MCKEE.

MALIGN TERATOID TUMOR IN THE HYPOPHYSEAL REGION. V. A. JENSEN, *Acta ophth.* 15: 193, 1937.

In a 13 year old girl lack of appetite, emaciation, headache, drowsiness, vomiting, pareses of the ocular muscles and bitemporal hemianopia developed. In the course of a short time papillary stasis and involvement of other cranial nerves appeared. A roentgenogram revealed destruction of the sella turcica. The patient died after two and one-half months, and autopsy revealed a large interpeduncular tumor, with extension into one sphenoid sinus and both orbits. Histologic examination showed a teratoid tumor. There are two photographs showing the tumor grossly but no photomicrographs.

O. P. PERKINS.

Ocular Muscles

CONGENITAL ABSENCE OF ABDUCTION (CONGENITAL MUSCULAR STRABISMUS). C. V. LODBERG, *Acta ophth.* 15: 247, 1937.

This article surveys the entire subject of congenital absence of abduction and cannot be well abstracted. Seven of the author's cases are briefly reported and the symptoms tabulated. The symptomatology is discussed in some detail, consideration being given to such topics as absence of abduction, limitation of adduction of the same eye, retraction of the globe, narrowing of the palpebral fissure, elevation of the globe on attempting adduction, protrusion of the globe and widening of the palpebral fissure on attempting adduction, difference in motility obtained by covering the fellow eye, head turning and vertical motility.

The pathologic anatomy underlying these functional disorders is discussed, reference being made to many of the various muscular anomalies recorded in the literature. There are brief sections devoted to etiology and treatment. This article, 50 pages long, in French, is well worth perusal by those interested in muscles. There is a bibliography of 90 references.

O. P. PERKINS.

Operations

ENUCLEATION WITH IMPLANTATION OF FOREIGN SUBSTANCES INTO TENON'S CAPSULE. C. BERENS, *Am. J. Ophth.* 20: 293 (March) 1937.

Berens believes that suppuration following implantation operations performed after enucleation may be due to buried sutures or unsterile catgut. He therefore uses a silk suture for Tenon's capsule but goes through the conjunctiva first before catching the capsule and cut tendons. The conjunctiva is then sutured with interrupted sutures. The deep suture is removed on the fifth day after operation. Forty-five eyes have been operated on in this manner and only two gold balls were expelled.

W. S. REESE.

THE USE OF EVIPAL SODIUM IN OCULAR SURGERY. D. ARGÜELLO and R. F. PEREIRA, Arch. de oftal. de Buenos Aires 12: 178 (April) 1937.

In this paper the authors extol the advantages of evipal sodium when a general anesthetic is necessary.

After reference to its use in other branches of surgery, as reported in the literature, they explain its use by slow intravenous injection, commencing with 1 cc. of a 10 per cent solution in distilled water. The quantity required varies greatly, less being required in children than in adults. If sleep occurs after the first injection, a wait of from a minute to a minute and a half before operating is indicated. Schnitzler advises injection of an extra 0.5 cc. and a wait of from three to four minutes. There is some fall in the arterial tension and in the frequency of the pulse beat. The patient wakes up shortly after the operation and rarely complains of headache or dizziness. Waking can be hastened by the administration of caffeine or of coramines (a 25 per cent solution of pyridine beta-carbonic acid diethylamine). Vomiting is rare. Occasionally there is some after-excitement, which can be avoided by the prior use of chloral hydrate or of morphine. Evipal sodium has been employed in patients from 7 months to 86 years of age. Exceptionally there is a great resistance to the drug. Its use is contraindicated in persons with hepatic lesions, peritonitis and severe anemia and in persons in shock or coma. In aged persons it is necessary to adhere strictly to indicated doses and technic. If the patient wakes up before the operation is finished, an extra injection can be given or the anesthesia continued with ether or chloroform. The advantages in favor of its use are: the suppression of the stage of excitement, the inhalation of a disagreeable narcotic, the absence of postoperative vomiting and psychic shock, the rapidity of action, the absence of complaints and the avoidance of the use of a mask. Evipal sodium combined with local anesthesia is at times useful. The authors have not experienced any accidents.

C. E. FINLAY.

Orbit, Eyeball and Accessory Sinuses

SEX-LINKED MICROPHTHALMIA SOMETIMES ASSOCIATED WITH MENTAL DEFICIENCY. J. A. FRASER ROBERTS, Brit. M. J. 2: 1213 (Dec. 18) 1937.

Roberts discusses a family showing microphthalmia and presents a genealogic table covering 4 generations. In the 4 generations there were 14 persons with microphthalmia, all males. Six of these were examined by the author. Of these 6, 2 were of normal mentality, 1 was feeble-minded, 2 were imbeciles and 1 was an idiot. At least 3 of the 8 persons not seen by the author were mentally defective. There was no other mental deficiency in the family group apart from that associated with the blindness.

The eyes of the 6 patients seen by Roberts are described briefly. In general, they fall into the classification (by van Duyse) of microphthalmia without coloboma but associated with various abnormalities, such as corneal opacities, aniridia, smallness or absence of the

lens and opacities of the lens. In all 6 cases the eyes were sunken in the orbits, and the intra-ocular tension was minus. Five patients had nystagmus. Four corneas were smaller than normal. Eight corneas were partially or totally opaque. The iris was abnormal in 7 instances and the lens in 6 (in the other 6 eyes the lens could not be seen because of corneal opacities). In all 6 patients the abnormality was detected immediately after birth.

In his discussion Roberts notes that the appearance of the eyes varied considerably in different persons and that the two eyes in a single individual were often strikingly different. As examination was not made of the brain of any member of this group, it is impossible to say whether the mental deficiency, when present, was due to specific malformations or whether the entire brain would show the underdevelopment and maldevelopment characteristic of the brains of ordinary mental defectives.

In these cases the microphthalmia was inherited as a sex-linked recessive condition, and the mental deficiency, when present, occurred only in the microphthalmic members of the family.

W. F. DUGGAN.

Pharmacology

THE EFFECTS OF MYDRIATICS UPON INTRAOCULAR TENSION. H. S. GRADLE, *Am. J. Ophth.* 19: 37 (Jan.) 1936.

In 500 consecutive patients past the age of 30 whose pupils had to be dilated for ocular examination Gradle made tonometric examinations immediately before the use of the mydriatic, two hours later and forty-eight hours later. He concludes that such measurements are highly advisable, as many cases of incipient glaucoma or preglaucomatous conditions may thus be found months or years earlier than they would be otherwise.

W. S. REESE.

Physiologic Optics

ANISEIKONIA. G. HARDY, *Am. J. Ophth.* 20: 599 (June) 1937.

This article appears to be a dispassionate, scientific effort to determine the value of iseikonic lenses. The following summary is given:

"1. Some patients are benefited by the addition of a size lens to the dioptric correction. The percentage aided, however, has been less than that reported from other clinics.

"2. The size differences of a symptomless group of persons wearing corrections for errors of refraction were equal to the size differences of those seeking relief from asthenopia.

"3. Not infrequently the dioptric correction is altered at the time the iseikonic lens is prescribed. Obviously, when this occurs it is not possible to determine, with any assurance, which change is helpful.

"4. The muscle balance was not appreciably influenced by the iseikonic lenses.

"5. Vertical size determinations were made with greater ease than lateral ones, that is, the patient had less difficulty in making comparisons.

"6. The chief objection to the method employed is that it is tedious, tiresome, and difficult for the patient.

"7. Sufficient numbers of symptomless individuals should be examined in order to determine, if possible, what a normal size difference might be.

"8. Those prescribing iseikonic lenses should avoid incorporating other changes; that is, a change in the strength of the lens should be made before the size correction is prescribed and not at the same time. Otherwise accurate deductions are impossible."

W. S. REESE.

Physiology.

THE INTRA-OCULAR FUSION MECHANISM. G. SCHUBERT, Arch. f. Ophth. 137: 506 (Oct.) 1937.

With Gullstrand's method of stigmatoscopy, Schubert demonstrated on himself and on other persons with normal binocular vision that on changing from uniocular (one eye covered) to binocular, symmetrical or asymmetrical convergence, a change in the dynamic refraction occurred in the eye that had been covered, in addition to the ocular movement for the correction of the slight amount of heterophoria. This change in refraction was consistent and characteristic of the conditions of the particular experiment. Schubert interprets these phenomena as changes in the degree of accommodative effort, changes which are made in the interest of fusion and which suggest the possibility of unequal accommodation in the two eyes. Thus, there is an intra-ocular fusion mechanism.

P. C. KRONFELD.

THE DIALYSATION OF THE INTRA-OCULAR FLUIDS. STEWART DUKE-ELDER, Brit. J. Ophth. 21: 577 (Nov.) 1937.

The author discusses the point raised by Robertson in a recent article (*Brit. J. Ophth.* 21: 401 [Sept.] 1937) and in his summary gives the following conclusions:

"In summary it may be stated that the aqueous humor is not a simple dialysate as I originally hypothesized. On the other hand there is no positive evidence for the theory that it is a secretion of the ciliary epithelium. An hypothesis which I had already adumbrated eighteen months ago is advanced, admittedly on experimental evidence which is yet insufficient for its full development, that, having dialysed from the intra-ocular capillaries and before reaching the chambers of the eye, the fluid passes through a physiological membrane the properties of which maintain a concentration gradient to some molecules, a degree of unidirectional permeability to other molecules, alterations in the properties of which may account for many obscure but important pathological phenomena. As our knowledge stands at the moment I can see little value in further arguments which must be based on insufficient premises: the sensible course is to continue in the search for further and more accurate experimental facts."

W. ZENTMAYER.

Refraction and Accommodation

REFRACTION ERRORS IN THE SAME EYES UNDER SCOPOLAMINE AND UNDER ATROPINE CYCLOPLEGIA. L. BOTHMAN, *Am. J. Ophth.* 20: 822 (Aug.) 1937.

Refraction was performed on 400 eyes under 0.5 per cent scopolamine hydrobromide and under 1 per cent atropine sulfate, and the results were compared. The following conclusions were arrived at:

"Scopolamine is not so complete a cycloplegic as atropine.

"The findings under scopolamine closely approximated those for atropine. In 18 per cent of the examined eyes there was no change. The difference in hyperopia was 0.37 D. less and in myopia 0.37 D. more than under atropine. The average difference in 400 eyes was 0.33 D. The difference between findings in patients over 40 years of age was almost negligible.

"Scopolamine is not a trustworthy cycloplegic when used for patients with good unaided vision if weak myopic or mixed-astigmatism errors are found, nor in patients under 16 years of age. Such patients should be refracted under atropine."

W. S. REESE.

Retina and Optic Nerve

COMPLETE RETINAL DETACHMENT (BOTH EYES). R. M. BALLYEAT, *Am. J. Ophth.* 20: 580 (June) 1937.

Ballyeat reports the case of a 21 year old woman in whom eczema developed at the age of 3 months and asthma and hay fever at the age of 1 year. At the age of 17 a retinal detachment appeared in one eye and then in the other. A roentgenogram revealed calcified deposits in each eye which appeared to be in the retina but were more likely in the vitreous or in the lens. The lenses were opaque. Ballyeat discusses the possibility of the detachments' being due to allergy, since the retina is of ectodermal origin and because of the allergic disturbances in the skin, which is also of ectodermal origin.

W. S. REESE.

DEFECTIVE CENTRAL VISION FOLLOWING SUCCESSFUL OPERATIONS FOR DETACHMENT OF THE RETINA. A. B. REESE, *Am. J. Ophth.* 20: 591 (June) 1937.

From a review of cases of retinal detachment in which operation was performed, Reese found that approximately normal vision (20/30) was obtained in only about one third of cases in which the operation was successful. He studied cases of detachment in the early stage in which there were no complicating features, in all of which there were cysts in the macula; indeed, they seemed to appear in the macula first and to there attain their largest size. The following conclusions were drawn:

"1. A cystic degeneration of the macula accounts for the poor central vision after the reattachment of a detached retina that involved the macular region.

"2. The defective central vision so frequently found following successful operations for detachment of the retina suggests that a macular detachment with cyst formation was present even though it might not have been recognized clinically."

W. S. REESE.

RARE FORMS OF TAPETORETINAL DEGENERATION: REPORT OF CASES.
K. LISCH, *Klin. Monatsbl. f. Augenh.* 98:498 (April) 1937.

Lisch observed an unusual form of tapetoretinal degeneration in 4 boys of a family of 6 children. One boy aged 13 and a girl aged 17 had healthy eyes.

Consanguinity of the parents did not exist, and ocular disorders in other members of the family were unknown, except in a sister of the children's father; she could not see well with one eye and had a cataract extracted. The ages of the 4 boys were 20, 19, 16 and 15, respectively. The vision was reduced in each of them, but it did not deteriorate allegedly except in the boy aged 19, who had bilateral holes in the macula. The peripheral field of vision was not considerably narrowed in any of them, and in two it was normal. Two boys had defects in the nasal and upper portions of the field, coupled with central scotomas and with reduced dark adaptation.

The changes in the maculas of these 4 boys consisted of irregular pigmentation and radial streaks, which may represent folds in the internal limiting membrane, produced by edema. The degenerative changes consisted of grayish white retinal foci of varying form and size and of fine irregular accumulations of pigment. Three boys had atrophy of the optic disks, which were not well outlined. The central retinal vessels showed invagination resembling perivasculitis. This symptom was considered indicative of marked pathologic involvement of the vascular system of the retina. The boys were intellectually normal, with the exception of the boy aged 19, who had choreatic restlessness and was physically underdeveloped.

K. L. STOLL.

HISTOLOGIC STUDY IN A CASE OF COMPARATIVELY RECENT SPONTANEOUS DETACHMENT OF THE RETINA IN AN AGED MYOPIC PATIENT. A. VOGT, *Klin. Monatsbl. f. Augenh.* 98:735 (June) 1937.

Vogt adds another case to the small list of cases of spontaneous detachment of the retina of from one day's to a few weeks' standing. The left myopic eye of a woman aged 72 was removed two years prior to observation. In front of the right eye, which showed myopia of 11 D., a shadow suddenly appeared, and detachment of the retina was found on the following day. Two days later preliminary katolysis was performed; the retina was partly reattached after three weeks, but the hole in the retina was still open. The patient's general physical condition rendered a second operation impossible. She died from peritonitis following an operation for inflammatory ectasia of the gallbladder thirty-seven days after the detachment was discovered. The eyeball was enucleated thirty minutes after death and hardened in a solution of formaldehyde. A detailed description of the histologic examination is given, with 14 photomicrographs, some of them colored.

The findings furnished evidence that the detachment could not have been caused by traction in the sense of Leber's and of Gonin's theories, because inflammatory changes in the vitreous were totally absent. Vogt reasons that degeneration of the retina is preexisting and that this degeneration causes the formation of the hole. Degeneration and slinging of

the vitreous are secondary symptoms. Some of the sections show cystic decay and marked thinning and atrophy of the retina near the hole. The ocular motion causes the slinging called "Jactatio corporis vitrei" by Vogt in his book; it exerts a pull on the fibers of the vitreous where they are attached to the thinned portion of the retina, so that the "lid" is torn off. Adhesions between the posterior portion of the vitreous and the internal limiting membrane occur in normal eyes. Salzmann called these solid adhesions in the periphery of the vitreous the "basis of the vitreous." The myopia of this patient cannot have caused the retinal tear by traction or overstretching.

K. L. STOLL.

LATENT HOLES IN THE RETINA WITHIN THE AREA OF A COLOBOMA OF THE CHOROID AND TRAUMATIC DETACHMENT OF THE RETINA: REPORT OF A CASE. R. TERTSCH, *Klin. Monatsbl. f. Augenh.* 98:751 (June) 1937.

Tertsch records 5 cases of coloboma of the choroid in the area of which traumatic detachment of the retina developed. He adds his own observation on a woman aged 30 whose right eye was struck by a piece of wood. The retina became detached over a congenital coloboma of the choroid, one of which existed also in the left eye. The retina in these areas in each eye consisted of a thin yellowish membrane, which showed several perforations; they were considered to be congenital, but latent. The injury produced a genuine detachment of the retina in this predisposed eye.

K. L. STOLL.

Trachoma

SPECIFIC TREATMENT OF TRACHOMA. V. DERKAČ, *Arch. f. Ophth.* 138:270 (Dec.) 1937.

Derkač transplanted pieces of trachomatous tissue (containing conjunctiva and follicles) directly from the eye of each of a group of young patients suffering from follicular nonsecreting trachoma into subcutaneous pockets on the forearm of the same patient. This procedure was repeated several times and seemed to have a definite beneficial influence on the course of the trachoma. In the majority of the patients treated with this method the trachoma became rapidly regressive and subsided after a few months. The author believes that patients so treated become more resistant against reinfection.

P. C. KRONFELD.

BRILLIANT GREEN IN THE TREATMENT OF TRACHOMA. T. K. KRYLOV and B. I. ROSTOVTZEV, *Sovet. vestnik oftal.* 9:902, 1936.

Twenty patients with recent trachoma without involvement of the cornea were treated with (1) instillations of a 1:200 and 1:500 aqueous solution of brilliant green (tetra-ethyl-diamino-triphenylmethane sulfate) twice daily and (2) subconjunctival injections from 0.1 to 0.5 cc. of a 1:1,000 and 1:4,000 solution of brilliant green in from three to six days. In a few cases one eye was treated with a copper sulfate pencil for a comparison of the results. The subconjunctival injections and the drops

were painful and caused a marked reaction. However, the instillation of drops usually stopped the excessive purulent discharge in one or two days.

The authors conclude that brilliant green does not improve the course of the trachomatous process and therefore has no value in the treatment of trachoma and that preference can be given to the old method of treatment with a copper sulfate pencil.

O. SITCHEVSKA.

Tumors

INTRASCLERAL EPITHELIAL CYST. M. SALZMANN, *Ztschr. f. Augenh.* 92: 275 (Aug.) 1937.

Five cases of this rather unusual condition are reported, with detailed histologic studies in 3. One cyst was successfully removed by simply dissecting away the outer wall, the epithelium of the inner wall being allowed to take the place of the normal conjunctiva. In all the cases the cysts followed perforating injury to the region of the limbus corneae by blunt instruments and were associated with prolapse of the iris and gapping wounds during healing. Four of the 5 cases occurred in children from 4 to 12 years of age. The cysts appeared some years after the original injury, and growth was accelerated later in the course of the disease. The shape of such a cyst is characteristically bean-shaped or kidney-shaped, or even sausage-shaped, with the largest circumference away from the limbus.

The largest tumor in Salzmann's cases extended as far back as the insertion of the inferior rectus muscle, but others have reported cysts in shrunken globes which have extended as far back as the optic nerve. There was no invasion of the cornea in this case, except where it was badly damaged by the original injury.

The cysts were scleral-white and covered with normal movable conjunctiva. The former factor alone differentiates this type of cyst from scleral ectasia and intercalary staphyloma. The edges of the cysts were sharply demarcated from the normal sclera. The cysts were translucent and had no pigment spots or streaks. Histologically, they were found to be lined with several layers of pavement epithelium. The basal layer was more similar to corneal than to conjunctival epithelium. Salzmann feels that this layer originates from the cells in the region of the limbus, which proliferates as it would in healing over a flat surface. The bulk of the walls of these cysts was made up of normal scleral connective tissue, as if the cysts had merely dissected in between the layers of the sclera. The occurrence in children and the limitation of the cysts to the anterior sclera where the lamination was more definite would uphold this idea. The cysts were filled with a clear fluid, which was felt to be a secretion product of the epithelium and not aqueous. In 2 of the cases part of the cyst was intra-ocular. In 1 case the cyst invaded the posterior chamber, and there was a free communication with the intra-scleral cyst. In the other case the cyst occurred in the anterior chamber, but no direct communication was found with the intrascleral cyst. The relation to epithelial cysts in the anterior chamber is obvious and is discussed at length. Drawings and photomicrographs illustrate the article.

H. GIFFORD JR.

TRAUMATIC CYST OF THE IRIS: REPORT OF A CASE. A. LUNDBERG, *Acta ophth.* 15: 204, 1937.

This article deals with the formation of a cyst in the anterior chamber of an eye injured in an explosion five and one-half years before removal. The cyst appeared two and one-half years after the injury and is ascribed to the proliferation of conjunctival epithelium driven into the eye by a minute foreign body. Three years later, because of secondary glaucoma, the eye was trephined and the cyst punctured. No benefit resulted. Electrolytic treatment of the cyst was also unsuccessful. One of these operative procedures probably lacerated the iris proper and so contributed to the formation of another cyst entirely within the substance of the iris. Three photomicrographs accompany the article.

O. P. PERKINS.

SARCOID OF BOECK: REPORT OF A CASE. E. HOLM, *Acta ophth.* 15: 235, 1937.

A man of 63 presented a thickening of the tissues beneath one lower conjunctival fornix. Below the outer canthus, a firm tumor the size of a bean was palpable. This was readily removed, though it was connected with the linear thickening along the lower orbital margin. There were no cutaneous lesions.

Microscopically, the tissue consisted of nodules of large epithelial cells in a connective tissue matrix. Isolated giant cells were found. There was no necrosis. Masses of lymphocytes surrounded the nodules. A diagnosis of Boeck's sarcoid was made.

Some sclerosis of the hilus glands and a strongly positive Pirquet reaction tended to support the theory which holds tuberculosis to be the causal agent.

O. P. PERKINS.

RING SARCOMA OF THE IRIS AND CILIARY BODY: REPORT OF A CASE. VON OVE BOJE, *Acta ophth.* 15: 239, 1937.

The case reported is notable first for the age of the patient, a 6 month old boy, and second for the extreme rapidity of the growth of the tumor, only three weeks having elapsed between the first appearance of a small brownish yellow spot on the iris and the extension of this pigmented area over the entire iris. The diagnosis made prior to enucleation was confirmed by microscopic examination.

O. P. PERKINS.

Uvea

UVEITIS: THE ROLE OF INTRAOCULAR TYPHOID-ANTIBODY CONTENT IN TREATMENT. A. L. BROWN, *Am. J. Ophth.* 20:583 (June) 1937.

Brown discusses the treatment of uveitis and reports 5 cases in which he used typhoid H antigen intravenously followed by aspiration of the anterior chamber. He summarizes the results in a group of cases in which this type of treatment was used. They were gratifying, and no untoward reactions or accidents were experienced.

W. S. REESE.

THE VALUE OF DIAGNOSTIC ROENTGEN EXAMINATION OF THE SPINE IN CASES OF IRITIS: REPORT OF CASES. H. SCHLEY, Klin. Monatsbl. f. Augenh. 98:780 (June) 1937.

To stress the difficulty encountered in establishing the correct cause of planar iritis, Schley refers to Gilbert's report on 500 cases, in over 17 per cent of which the origin remained unknown. Roentgen examination of bones and joints, especially of the small bones of the spinal column, has recently become valuable in arriving at the cause of the lesion. The most frequent conditions revealed in the roentgenograms are spondylarthrititis ankylopoietica and spondylosis deformans. Schley compiled reports of 105 cases of iritis, 32 of which were of the localized type and 73 of which were of the superficial type. Four cases are reported in detail. The patients were observed at the University Eye Clinic of R. Thiel in Frankfort on the Main. The results of the examinations of the spine were as follows: 1. Patients with tuberculous and syphilitic iritis showed absolutely no changes in the spine. 2. In 73 patients the superficial iritis had a clear rheumatic causation, the diagnosis being based on the results of the clinical examinations and the therapeutic effects of salicylic acid and other antirheumatic agents. Of these 73 patients, 10 had spondylitis ankylopoietica, 40 had spondylosis deformans, while 23 showed no changes in the spine.

According to Junghanns' statistics, spondylosis deformans is equally frequent in both sexes; after the fifth decade of life almost 80 per cent of all men and over 60 per cent of all women suffer from it; after the seventh decade more than 90 per cent of all human beings are afflicted with it. Schley is not of the opinion that rheumatic iritis is caused by spondylosis deformans, except in some rare cases cited. He considers this disease of the spine as the result of wear and tear during life and the iritis associated as an incidental condition. Schley found no support for Krebs' opinion that spondylosis deformans may develop on an inflammatory base if the sedimentation time of the blood is increased. The diagnosis of true rheumatic iritis may be difficult, but the condition is associated with spondylitis ankylopoietica in only a small number of cases.

K. L. STOLL.

Sympathetic Ophthalmia

THE RHINOGENIC ORIGIN OF SYMPATHETIC OPHTHALMIA. B. WALDMANN, Am. J. Ophth. 20:618 (June) 1937.

After improvement in several cases of serous iritis in which nasal treatment was employed, Waldmann comes to the following conclusions:

"Spontaneous serous iritis and sympathetic ophthalmia are identical affections. Both are seasonal ailments, and the common causative agents are lodged in the nose.

"Injury, operation, likewise tuberculosis and syphilis only serve to prepare in the uvea a site of lowered resistance."

W. S. REESE.

Therapeutics

ADRENALIN CHLORIDE 1:100 IN OPHTHALMOLOGY. O. BARKAN and S. MAISLER, *Am. J. Ophth.* 20: 504 (May) 1937.

Barkan and Maisler have found the instillation of drops of a 1:100 dilution of epinephrine hydrochloride into the conjunctival sac a very satisfactory substitute for subconjunctival injections of synthetic preparations of epinephrine. This dilution of epinephrine is very stable, and its administration by this method does not require anesthetization. It does not seem to cause systemic or local reactions. The authors refer particularly to the use of epinephrine hydrochloride in the treatment of glaucoma secondary to uveitis.

W. S. REESE.

AUTOHEMOTHERAPY IN PARALYSIS OF OCULAR MUSCLES. R. CAMPOS, *Riforma med.* 53: 1439 (Oct. 9) 1937.

Campos reports satisfactory results from autohemotherapy in 2 cases of paralysis of the ocular muscles following hemiplegia of nuclear origin. The technic is as follows: Twenty cubic centimeters of blood is taken from a vein of the patient's arm and immediately reinjected at the gluteal region, which is then massaged for some time. The injections are made at intervals of two days alternately on each side of the gluteal region until ten injections are given. The condition of the author's patients was slowly but progressively aggravated during the first month before he resorted to autohemotherapy. The latter induced in both cases complete regression of the symptoms and functional reestablishment in about one month. The treatment is simple and harmless.

J.A.M.A. (W. ZENTMAYER).

SHORT WAVE THERAPY IN OPHTHALMOLOGY. J. KRAUSE, *Ztschr. f. Augenh.* 89: 266 (July) 1936.

A review of the literature from 1935 indicated that short wave therapy had been applied to ocular conditions of various types with varying degrees of success. Favorable results were obtained in cases of herpes simplex, herpes zoster, interstitial keratitis and serpent ulcer. Rabbits with herpes simplex improved for one or two days, and then the lesions continued to spread.

The treatment of abscesses of the lid and orbit and acute dacryocystitis was reported by Sattler to give exceptionally good results. Twelve patients with iritis were also improved with short wave therapy. Wegener reported a case in which retinal hemorrhage occurred while treating a patient with a tuberculous process.

The experimental work of Krause showed that treatment of normal rabbits on ten consecutive days for periods of a half hour produced only slight hyperemia of the globe. None of the changes reported by Grüter were seen. He observed rather rapid healing of experimentally produced staphylococcic ulcers in animals when a wavelength of 4 meters was used. In a second series in which a wavelength of 6 meters was used the results were indefinite.

Experiments on pigs' eyes showed that the temperature of the globe was raised equally well by having the electrodes slightly out

of line as by having them exactly opposite each other. Similar results were observed on an eye embedded in fat in a human skull with one electrode on the temple and one slightly to the nasal side of the globe. In this position there is no heating effect produced in the brain which might possibly be a disadvantage. Slightly larger electrodes gave slightly higher temperatures. The larger electrode measured 4 cm. in diameter. The glass around it measured 5 cm., and the distance of the electrode from the front of the glass was 3 cm. The smaller similar electrodes measured 1.8, 2.5 and 1.5 cm. The distance from the skin is regulated by its tolerance for heat but should not be made too small.

In general, Krause's clinical results were similar to those published in previous reports. Hordeolum, abscesses of the lid and dacryocystitis responded surprisingly well. In 1 case of panophthalmitis prompt healing occurred. In 1 case of sympathetic ophthalmia no improvement had occurred with five treatments, and eight days after the last treatment there was hemorrhage in the anterior chamber. In 1 case of herpes and 2 of disciform keratitis no special results were noted. Krause believes that many more conditions should be treated with the short waves before the clinical value of this form of therapy for diseases of the eye can be determined. The healing action of the short waves was limited to the ability to increase the temperature of the tissue and the resulting hyperemia.

H. GIFFORD JR.

Society Transactions

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L. W. DEAN, M.D., St. Louis, *President*

Forty-Second Annual Session, Chicago, Oct. 10-15, 1937

SCIENTIFIC SESSION: OPHTHALMOLOGY

CHLOROMA: REPORT OF A CASE. DR. A. D. FROST, Columbus, O.

A boy aged 4 years was first examined by me because of swelling of the left upper lid of two months' duration. He felt perfectly well and had no other complaints. Physical examination revealed a well nourished boy, of normal development. Except for a few palpable posterior cervical and axillary lymph nodes, exophthalmos and downward displacement of the left eye were the only abnormal findings. The exophthalmos was caused by a circumscribed, somewhat nodular, hard tumor mass, which was slightly visible between the globe and the lateral portion of the roof of the orbit. Examination did not reveal any edema of the conjunctiva, lagophthalmos, loss of motility or diplopia. The vision was normal so far as could be determined by illiterate tests, and the fundi were normal. A roentgenogram of the skull and orbit did not reveal any osseous changes or destruction. Two weeks later there was a noticeable enlargement of the tumor of the left orbit, and in addition another tumor had appeared in the same position in the right orbit. The blood count at this time showed 32,000 white cells, with approximately 82 per cent myelocytes. The tumor was removed from the left orbit; it measured 3 by 3 by 1 cm. Gross examination of the tumor and the frozen sections established the diagnosis of chloroma.

After the patient made a satisfactory convalescence, a total of 2,400 roentgens was administered in eight applications. About six weeks later the tumor of the right orbit was removed and was found to be pathologically identical with that removed earlier from the left orbit. The patient's condition improved for a time, but three weeks after the last operation he failed rapidly. There were pain in the abdomen and abdominal distention, followed by involuntary defecation and urination, rectal prolapse and bleeding. The temperature rose to 104 F., and the breathing became labored; death followed.

Pathologic study revealed that the soft tissues about the right eye were ecchymotic, swollen, ulcerated and injected. The mesenteric lymph glands were slightly enlarged; the sternum showed a slight bluish nodularity on the left side; the spleen weighed 110 Gm., and the peripancreatic lymph nodes were markedly enlarged. There were many greenish nodules along the vertebrae and ribs. The peculiar dirty grayish

green character of the tumor, its predilection for periosteum and the established myelogenous leukemia placed it in the class of tumors called chloroma.

DISCUSSION

DR. T. L. TERRY, Boston: The great difference between chloroma and myelogenous leukemia is that the former is characterized by the development of a green tumor. The significance of the tumor may not be known until the cause of the green color is fully understood. There have been many attempts to explain the color, as Dr. Frost has pointed out. Thomas and Bigwood (*Compt. rend. Soc. de biol.* 118: 381, 1935) expressed the belief that it is due to porphyrin, since they have shown the presence of free porphyrin in the tumor by spectroscopic study and have recovered porphyrin from the tumor by extraction with glacial acetic acid and ether.

Why do these green tumors have a predilection for growth in orbital tissue? The orbit is remarkably free from lymph nodules. It must certainly have lymphatic channels which have little or no connection with the lymphatic channels of the face and neck. It is possible then that the very lack of free communication of lymph channels to the face and neck may tend to produce a physiologic lymph stasis in the orbit. Such a condition would favor development of myelogenous, chloromatous or lymphomatous nodules.

The appearance of white centers in retinal hemorrhages is presumably diagnostic of leukemia, although this change is not invariably present. The white area is due to an accumulation of abnormal white blood cells in the center of the hemorrhage. I should like to ask Dr. Frost if this change is also observed at times in cases of chloroma.

DR. GEORGIANA DVORAK-THEOBALD, Chicago: Chloroma is a rapidly growing malignant neoplasm, involving the hemopoietic system, with metastases of cells to distant organs, and associated with a leukemic blood picture. It is almost invariably fatal, with a duration of from three to five months after recognition.

Up to the present, about 200 cases have been reported in the literature.

The most characteristic sign is the predilection of such tumors for the periosteum of the cranial bones, especially of the orbit.

The rapidity of growth and the extent of the orbital tumor may give rise to a number of ocular symptoms, namely, exophthalmos, drying of the cornea (due to extreme proptosis), optic neuritis, retinitis, sluggish reactions of the pupils, anisocoria, mydriasis, conjunctivitis, cataract, exotropia and nystagmus. In one type of chloroma the aural structures are affected.

The tumor apparently arises from a localized growth of leukemic deposits or metastases, and the tumor cells metastasize in the blood to produce leukemia.

In about half of the cases the periosteum of the orbital bones is the site of predilection. Why this is so is not known.

Differentiation between chloroma and myeloma is based on the usual blood picture of leukemia and the green tumor in cases of chloroma and on the tendency to spontaneous fracture in cases of myeloma. The Bence Jones type of protein is usually present in the urine of patients with myeloma and is only rarely present in that of patients with chloroma.

It is thought that the green color of chloroma is due to a lipochrome or to a blood pigment, but nothing is definitely known. According to Roehn and his associates, it is due to phagocytosis of the blood by endothelial cells in obstructed capillaries.

DR. A. D. FROST, Columbus, O.: I did not observe any retinal hemorrhages in this case, nor did I find any discussion of this subject in the literature. In most cases of myeloid leukemia, I understand, there are no characteristic retinal hemorrhages, but they are prevalent in cases of lymphatic leukemia. A probable explanation may lie in the fact that in the lymphatic type of leukemia there is more definite thrombopenia than there is in the myeloid type.

I might add that the autopsy did include a rather thorough examination of this boy's one eye, and I have never had a better section of a normal eye throughout.

EPITHELIAL INVASION OF THE ANTERIOR CHAMBER OF THE EYE FOLLOWING OPERATION AND INJURY. DR. C. A. PERERA, New York.

A survey of the literature reveals that epithelial invasion of the interior of the eyeball produces three different types of lesions: (1) "pearl" tumor of the iris, (2) post-traumatic cyst of the iris and (3) epithelization of the anterior chamber. In a patient with lifelong myopia of high degree a cataract developed; it was removed within the capsule after preliminary iridectomy. Extraction was followed by incarceration of the temporal pillar of the iris in the operative wound, mild uveitis and prolapse of the vitreous into the anterior chamber. Vision with correction was later improved to 20/30. More than fourteen months later the eye became congested and a cyst was found lying between the temporal pillar of the iris and the posterior surface of the cornea. The right eye was treated with five doses of 150 roentgens at weekly intervals until a total of 750 roentgens had been given, a 200 kilovolt peak, a filter of 0.5 mm. of copper and a skin-target distance of 50 cm. being used. When the patient was examined in June 1935, the cyst had shrunk to a light yellowish mass. In August 1935 a slight reformation of the cyst had taken place, and a second series of five treatments was given, a 108 kilovolt peak, a filter of 3 mm. of aluminum and a skin-target distance of 25 cm. being used. The patient's right eye received a total of 1,550 roentgens in the two series of treatment. By the middle of October 1935 the cyst had disappeared. When the patient was examined in August 1937, there was still no evidence of a cyst in the anterior chamber of the right eye.

A flap of superficial corneal tissue was introduced experimentally into the anterior chambers of rabbits. The corneal epithelium, which proliferated rapidly immediately after the operation, gradually became degenerated and disappeared. The entire implanted flap became absorbed within three weeks, with the formation of an anterior adhesion of the iris in all rabbits. Epithelization of the anterior chambers of normal rabbits could not be produced by this method.

DISCUSSION

DR. F. BRUCE FRALICK, Ann Arbor, Mich.: This condition has been observed but twice in the past decade in the ophthalmologic clinic

of the University of Michigan. It followed a perforating injury in each instance. In 1 case the epithelial invasion was through the center of the cornea, resulting in an epithelial cyst of the anterior chamber, and in the other case an hourglass epithelial cyst developed, lining the anterior and posterior chambers, and communicated through the limbus with a large subconjunctival epithelium-lined cyst. In the latter case the conjunctiva was apparently injured, and in addition there was a subconjunctival perforation at the limbus into the anterior chamber. Both eyes were glaucomatous when seen. In both instances serial sections revealed evidence of iris tissue incarcerated in the perforation, as found in Dr. Perera's case.

It is encouraging to hear of another favorable therapeutic result by the use of roentgen irradiation, since most conscientious roentgenologists will not admit of a selective affinity of the roentgen rays for normal surface epithelium. If no such selective action on the part of the roentgen rays exists, the question must be asked as to how they could destroy surface epithelium growing in the anterior chamber and yet not destroy the same epithelium on the anterior corneal surface, where it is closer to the source of radiation and thus receives a more intense dose. It might be that the epithelium in the anterior chamber is growing under such unfavorable circumstances that it is vulnerable to a dose of roentgen rays which would have no harmful effects on the same tissue when growing in its normal environment.

Dr. Perera used high voltage roentgen radiation, which is considered as "deep therapy." In the treatment of epithelial cyst of the anterior chamber one is concerned not with deep penetration but rather with the superficial therapeutic effects; so the filtration and kilovolt peak used could be considerably decreased and yet give the same ionization in the anterior chamber of the eye. This suggestion is offered not as a criticism of Dr. Perera's technic, since a brilliant result was obtained, but merely to point out that the same ionization or destruction of the epithelial cells in the anterior chamber should be obtained without the use of roentgen rays which have such depth of penetration. If a low penetrating beam of roentgen rays generated at low voltages was used instead of high voltage, or "deep," therapy, it might be an important factor in preventing the formation of cataract or vascular degeneration in the retina or in the choroid.

DR. W. E. FRAY, Philadelphia: I think that Dr. Perera has developed an interesting experimental method to study this condition. Although his results are essentially negative, I believe that they are nevertheless important.

One obvious conclusion which may be drawn from this is that corneal epithelium implanted in the eye of a healthy rabbit is rapidly absorbed and destroyed, and in order to obtain growth and continued proliferation of epithelium into the anterior chamber some other factor is necessary, such as trauma, inflammation or some degenerative condition.

In slides illustrating this condition, of which I have been able to examine a number which are in the collection of the Wills Hospital, there is either absence of or marked degenerative change in the corneal endothelium. In one such slide the endothelium is absent even at places where epithelial tissue does not cover the posterior corneal surface.

Previous experimenters have reported fistulization and continued hypotonia as important predisposing causes of the proliferation of epithelium. It does not seem to me that the continued hypotonia is a primary cause; it seems, rather, that the continued hypotonia is responsible for other damage in the eye which permits epithelium to continue to grow.

REFRACTIVE ERRORS IN THE SAME EYES WHILE UNDER THE INFLUENCE OF HOMATROPINE, SCOPOLAMINE AND ATROPINE. DR. LOUIS BOTHMAN, Chicago.

This is a report on the analysis of changes in refraction in 200 eyes (100 persons under 40 years of age) while under the influence of the drugs most commonly used in retinoscopy—homatropine hydrobromide, scopolamine hydrobromide and atropine sulfate.

All of the eyes were examined by retinoscopy at a distance of 1 meter, a concave mirror being used. Homatropine hydrobromide in a 2 per cent aqueous solution was instilled into the conjunctival sacs. Six drops were used at intervals of ten minutes, and the retinoscopic examination was made ten minutes after the final drop was given.

Scopolamine hydrobromide was used in 0.5 per cent aqueous solution. Two drops were used at intervals of a half-hour, and the test was made fifteen minutes after the second drop was instilled.

Atropine sulfate in a 1 per cent aqueous solution was used by the patient before retiring the first night and four times daily for three days and in the morning of the day of the examination. In all, 14 drops were used. Scopolamine is a more complete cycloplegic than homatropine, while atropine gives more complete cycloplegia than either of the other two drugs.

DISCUSSION

DR. ROBERT J. MASTERS, Indianapolis: Ophthalmologists agree that the use of a cycloplegic is absolutely essential to the accurate measurement of the refraction of the eyes of persons under 45 years of age. Homatropine should not be used in a concentration as weak as the 2 per cent solution of the hydrobromide. When used in this strength it has seldom been an effective cycloplegic in my experience. For satisfactory results a 4 per cent solution should be employed, with or without the addition of cocaine hydrobromide to make a 2 per cent solution of the latter. Five instillations at intervals of from ten to fifteen minutes with retinoscopic examination begun from seventy to eighty minutes after the first instillation, have given cycloplegia that has been consistently satisfactory during seven years of experience. The drops are always instilled by my brother or myself. I have mentioned this only to drive the point home that it is better for the physician to instill the drops himself than to have an office assistant do it, and every one knows that it is more satisfactory to do it oneself than to have the drops instilled in the home.

DR. JOHN F. GIPNER, Rochester, N. Y.: Dr. Bothman is obviously in favor of atropine sulfate, since he uses 14 drops of a 1 per cent solution within three and a half days and only the generally accepted minimal doses for the weaker drugs. As one who has found homatro-

pine usually satisfactory, I wish that he had made, or would in the future make, a better case for the two weaker cycloplegics, giving them an opportunity to establish as complete cycloplegia as possible by varying the dose or strength of the solutions as is found necessary.

Certainly the almost universal use of the weaker cycloplegics reflects the demand of the public for the least prolonged disability to the accommodation which is commensurate with reasonable accuracy in measuring refractive errors.

Whether or not one will use atropine in routine refraction will largely depend on one's philosophy of the art and science of refraction.

If one proceeds on the concept that the full correction of the refractive errors as found with complete cycloplegia is necessary for the comfort of the patient and that one can only consider a scientific reduction of the patient's refractive error to the emmetropic state with glasses, then one will use atropine sulfate alone in examining all patients for refraction.

However, if one proceeds on the basis of another philosophy of the art and science of refraction and chooses to be less the scientist but more the artist in examining patients, and if one respects hypertrophy of the ciliary muscle as physiologic and worthy of keeping as long as symptoms of accommodative strain are controlled, one will give more consideration to the control of accommodation in refraction with milder cycloplegics and will also master the art of manifest refraction.

DR. OSCAR WILKINSON, Washington, D. C.: About twenty years ago I studied a series of 50 patients with refractive defects, employing homatropine and atropine as cycloplegics. I concluded that with the atropine there was a greater amount of refractive defect in a considerable number of the patients, but this defect was usually under 0.5 diopter. I found the amount of astigmatism and the axis of astigmatism to vary little. I believe that the eyes of all subjects under 14 or 16 years of age should be atropinized, as the difference in the refractive defects obtained with the two drugs was greater in the younger patients. The history of the patient may have a great deal to do in determining which drug one should use. In other words, I believe that if a patient even over 20 years of age has not been satisfactorily fitted with glasses, or at least is still having trouble with his eyes after numerous examinations, atropine should be employed.

As to the use of homatropine, I find that if it is used the night before examination and again in the morning, as was recommended by Dr. Bothman, and in addition an occasional drop of a weak solution of cocaine hydrochloride is used, the cycloplegia will be satisfactory.

With reference to scopolamine and its toxic effect, I have found that young subjects who come to the office with empty stomachs are more susceptible to intoxication from this drug than those who come in after having eaten. It is now my custom, particularly for young subjects, to tell them that they had better eat something before coming to the office.

DR. ALFRED COWAN, Philadelphia: All one needs to do to determine whether or not a cycloplegic is satisfactory is to measure the accommodation at the time of refraction. For the ordinary examination I use cycloplegics to help to determine the static refraction. It seems to me,

as Dr. Gipner brought out, that the interval of time employed by Dr. Bothman, that is, fifteen minutes after the last instillation of scopolamine hydrobromide, is rather short. I always wait longer than ten or fifteen minutes after the last instillation, of the fifth or sixth drop of homatropine hydrobromide. It is advisable to instill 1 or 2 drops in each eye in the evening. The next morning 6 or 7 drops are used at intervals of fifteen minutes, and the retinoscopic examination is made not sooner than half an hour after the last instillation. The accommodation is measured before proceeding with the refraction. If the residual accommodation is more than 1 or 1.5 diopters or even 2 diopters, I use another cycloplegic. But if good results can be obtained with a cycloplegic the effect of which lasts twenty-four hours, why should one be used the effect of which lasts ten days, even for a boy or girl 13 or 14 years of age?

BENZEDRINE IN CYCLOPLEGICS: II. A FURTHER REPORT. Dr. S. JUDD BEACH and DR. W. R. MCADAMS, Portland, Me.

This is the report of more definite data on the use of benzedrine with cycloplegics for refraction, certain advantages of which were pointed out previously. This possibility was suggested by a statement in a paper of Myerson's on the pharmacology of benzedrine, which claims that complete but temporary cycloplegia follows the use of benzedrine with atropine in attenuated solutions. The action which results is as though atropine inhibits the circular fibers of the ciliary muscle and benzedrine stimulates the radial fibers. Thus an intense dilatation of the muscle results, with corresponding relaxation of accommodation, but of shorter duration than when atropine is used again and again. We do not understand that it is the presence of benzedrine that hastens the recovery; it is rather the use of less atropine.

In our clinics the cycloplegia resulting from a single instillation each of benzedrine and atropine appeared to be essentially as complete as would be anticipated from a cumulative dose of atropine alone, and of vastly shorter duration. We also found a similar action with homatropine, which passed off with astonishing rapidity. Both drugs seemed satisfactory for refraction. Our experiments also indicate a synergism with scopolamine and with euphthalmine.

Results were gaged by retinoscopic examination, with the eye fixing at different distances, and more certainly, by comparing static refraction for distant and for near vision. With intelligent patients, amplitude was measured with a +3 addition at 33 cm. With homatropine the effect on one eye of a single instillation followed by the instillation of benzedrine was also compared with that on the fellow eye, produced in the orthodox way by multiple administrations of homatropine without benzedrine.

The present report compares the action of the two methods on the same eye. Single instillations of the cycloplegics with benzedrine were used first, and the effect was measured. When it had worn off, repeated doses without benzedrine were administered in the conventional manner.

Cycloplegia from benzedrine and homatropine is rapid. Often it is well advanced in from twenty to thirty minutes and at its peak in from fifty to seventy minutes. The fall begins soon, so that the examination should be under way within the hour. The recovery progresses rapidly, so that patients examined in the afternoon have claimed to read at 7

or 9 o'clock in the evening, and many by 11 o'clock. They can usually return to work the next morning. The effect from atropine and benzedrine is also likely to reach its height in an hour, but a small increase may continue for a half or three quarters of an hour longer. After its use, patients have read in one day, but ordinarily from two to four days are required.

We have found the benzedrine method especially useful in the care of out-of-town patients and in the clinic. When time is short, the action is quick. No potent drugs need be given incompetent parents. Systemic effect causes no anxiety. Cycloplegia is possible when a second visit cannot be made for examination and when a student or an adult must return to work immediately. Patients enthusiastically welcome the freedom from annoyance and the rapid recovery. When results are uncertain, the orthodox method can still be employed.

At present, it is our feeling that in critical cases prolonged atropinization is probably justified to compel the utmost reaction, although it is not as reliable as generally believed. In general, the gain over the benzedrine method is so slight and uncertain that it is doubtful whether it often compensates for the loss of time.

DISCUSSION

DR. HUNTER H. MCGUIRE, Winchester, Va.: My conclusions, though based on a much more limited experience, are in entire accord with those of Dr. Beach. The distinct advantage of being able to induce complete cycloplegia under supervision in one's own office in the shortest possible time and the definite shortening of the period of recovery should appeal to both physician and patient. Thus far, my experience convinces me that the method will stand the test of time.

DR. CONRAD BERENS, New York: Cycloplegia from benzedrine and homatropine is rapid. Often accommodation is markedly paralyzed within from twenty to thirty minutes, and in the majority of cases it is almost completely abolished in from thirty to sixty minutes. The residual accommodation did not exceed 0.25 D. in 70 per cent of 23 eyes studied. In this respect the results are similar to those obtained with the orthodox method of using atropine. The use of atropine sulfate in 1 per cent solution three times a day for three days caused a reduction of only 0.25 D. in accommodation when compared with one instillation of benzedrine and homatropine. After the use of the latter drug, most patients may use their eyes for reading within from three to six hours.

FILTER-PASSING AGENT AS A CAUSE OF ENDOPHTHALMITIS. DR. JONAS S. FRIEDENWALD and CLARA MCKEE, Baltimore.

In a case of bilateral uveitis with papillitis the cell count in the spinal fluid was increased. On inoculation of an animal with the patient's spinal fluid a virus was secured which produced characteristic intraocular inflammatory lesions when inoculated into the eyes of rabbits, dogs and cats. The virus passes the Berkefeld V filter more readily than the Seitz filter. It can be cultivated on the chorioallantoic membrane of chick embryos and can be preserved for several months in anaerobically sealed Berkefeld filtrates of infected tissues and in glycerinated emulsions of infected tissues. The virus produces in rabbits lesions somewhat

similar to those produced by the virus of periodic ophthalmia of horses, but the evidence at hand would indicate that the two viruses were not identical.

DISCUSSION

DR. ALBERT L. BROWN, Cincinnati: The report lends itself to discussion on three subjects: (1) the virus as an isolated phenomenon, (2) its action on the eye and other organs and (3) its relation to the pathogenesis of human uveitis.

The case reported is apparently one of uveitis, albeit with certain unusual characteristics. The description of the eye suggests a composite of bilateral optic neuritis and generalized uveitis, which the authors wisely call endophthalmitis. In the absence of all other findings in the patient, a virus was isolated from the spinal fluid which survived many intraocular passages in animals. This may simply indicate that the vitreous is a favorable medium for the virus, but it does not necessarily prove that it has specific properties to produce ocular lesions. The ocular reactions in the various animals were all produced by direct intraocular injection. These reactions, especially in cats, seemed to be severe endophthalmic effects rather than any specific tissue entity seen in human beings. The lesions, especially those revealed by the microscope, were lodged variously in the retina, optic nerve and uveal tract. The predominant tissue effects depended on the species of animals used. Experimentally, the virus could not be said to produce any characteristic ocular pathologic entity.

PERSONAL EXPERIENCES WITH INTRACAPSULAR CATARACT EXTRACTIONS. DR. FREDERICK A. DAVIS, Madison, Wis.

This paper will appear in full in a later issue of the Archives.

OCULAR MANIFESTATIONS OF ENDOCRINE DISTURBANCE. DR. ALBERT M. LEMOINE, Kansas City, Mo.

This paper was published in full in the February 1938 issue of the ARCHIVES, page 184.

DISCUSSION

DR. A. D. RUEDEMAN, Cleveland: My own experience with endocrine disturbances has been rather unsatisfactory, for the simple reason that after a diagnosis is made there is little in the way of treatment to offer most of the patients. If I might offer some advice I should say that when one makes a diagnosis one should leave the door open just a little so that a second diagnosis can be made, for in most instances it is rather difficult to get a substantiation of one's conclusions. It is well known that there are few accurate tests for endocrine dysfunction and that when one does establish an accurate diagnosis there is little that can be done in the way of treatment. Few patients with hyperthyroidism, the one field I think that offers the most to the ophthalmologist, are seen when it is too late to help them much as far as the condition of the eyes is concerned.

There is a field, however, in which the ophthalmologist should play a part and that relates to acute hyperthyroidism in adults. Hyper-

thyroidism developing in an adult offers a diagnostic opportunity to the oculist, and the oculist usually misses it. A survey of a group of patients revealed that 75 per cent of those who had acute hyperthyroidism with progressive exophthalmos had been given glasses during the acute phase of the disease and during the progression of the exophthalmos. A taking of the pulse rate, or merely examination with Hertle's exophthalmometer, would have shown the operator that there was exophthalmos and that it was due to disease of the thyroid gland. The condition in such cases should be regulated by the oculist and not by the surgeon.

DR. CHARLES A. BAHN, New Orleans: As knowledge increases, ophthalmologists are becoming less dogmatic about the role that specific dysfunction of the endocrine glands plays in the causation, aggravation or association of ocular symptoms. The following etiologic classification has been of service in my courses of instruction during the past several years: (1) ocular symptoms caused by endocrine dysfunction; (2) ocular symptoms aggravated by endocrine dysfunction, and (3) ocular symptoms associated with endocrine dysfunction, the causative relation being as yet undetermined.

The first group is illustrated by bronzing of the lids, more or less characteristic opacities in the cornea and lens, uveitis, retinitis and changes of refraction in cases of pancreatic diabetes; by pigmentation of the lids in cases of Addison's disease; by perinuclear opacities in cases of hypoparathyroidism, and by visual disturbances, with or without inflammation, involving the retina and the optic nerve in some cases of lesions of the pituitary gland.

The second group is illustrated by the increased severity of diseases of the uvea and of the retina and the optic nerve of different forms during menstruation, pregnancy and menopause; by the increased frequency of interstitial keratitis in cases of congenital syphilis associated with hypothyroidism, and by the increase of pyoderma of the lids during adolescence.

The third group is illustrated by the association of retinitis pigmentosa with polydactylism, obesity, genital underdevelopment and psychic changes, which together form the Laurence-Moon-Biedl syndrome. In this syndrome a form of congenital pituitary dysfunction is apparently involved. Another illustration is the association of conical cornea with the Fröhlich type of pituitary dysfunction; angioneurotic edema with adrenal insufficiency; blepharitis and premature presbyopia with hypothyroidism, and numerous congenital ocular defects, disease of the thyroid and other transmissible endocrinopathies.

Whether or not the foregoing examples are accepted in the order in which I have placed them is of minor importance. More important is that one learns to think of ocular symptoms of an endocrine nature in terms of causation, aggravation or association.

FURTHER STUDIES ON THE REGENERATION OF THE AQUEOUS IN MAN.
DR. PETER C. KRONFELD, and DR. C. K. LIN.

The intraocular tension of the human eye immediately after puncture of the anterior chamber depends on the relation between the volume of the anterior chamber and the volume of the entire globe.

The interval of time necessary for restoration of the intraocular pressure in the nearly normal human eye to the original level depends on the original volume of the anterior chamber. The rate at which new intraocular fluid is formed in the nearly normal human eye after puncture of the anterior chamber appears to be independent of the original volume of the chamber.

The intensity of the reactive ocular changes which follow puncture of the anterior chamber and manifest themselves as the hypertensive phase seems to be proportional to the intensity of the eliciting stimulus, that is, to the amount of fluid withdrawn.

COLLEGE OF PHYSICIANS OF PHILADELPHIA,
SECTION ON OPHTHALMOLOGY

CHARLES R. HEED, M.D., *Chairman*

Oct. 21, 1937

ALEXANDER G. FEWELL, M.D., *Clerk*

SUBCHOROIDAL HEMORRHAGE SURROUNDING THE OPTIC NERVE. DR. E.
GIRARD SMITH.

The patient was admitted to the University Hospital on Oct. 14, 1937, complaining of distortion of objects seen with the right eye.

About September 1 the patient suddenly noted that objects viewed with the right eye were smaller than those viewed with the left eye. There were no other suggestive symptoms. Five months prior to admission he was in an automobile accident and was taken to another hospital, where a large gash over the right temple was sutured. Recovery was uneventful. On his admission to the University Hospital vision in the right eye was 6/30 and in the left eye, 6/6.5. Vision in the right eye through a pinhole was 6/15—2. A large scar was observed over the right temporal region. External examination of the eye gave negative results. Examination of the right fundus showed the media to be clear, the disk round and the margins fairly well outlined. Surrounding the inferior nasal and inferior temporal parts of the disk was a slate-colored area, extending outward approximately from 1 to 2 disk diameters. Surrounding this area were hemorrhages, which were striated and apparently in the deeper layers of the retina. The retina over the affected area was raised about 1.5 D., and there were traction bands running toward the macula. Roentgenograms of the skull were normal. The pressure of the spinal fluid was 170 mm. of water, and its protein content was 45.25 mg. per hundred cubic centimeters. There were no blood cells in the fluid. The blood was normal. With a 1 mm. white test object at 1,000 mm., the central visual field showed an enlarged blindspot, with a large cut in the temporal field. It was thought that the patient might have a chronic subdural hemorrhage, but examination by Dr. Francis Grant failed to disclose any signs of it.

This case is presented because of the diagnostic problem. The lesion of the fundus could be due to a sarcoma, but I believe this rather unlikely. I believe that the slate-colored area below the disk is due to blood in the subchoroidal space, which has traveled along the sheath of the optic nerve. It is interesting to note that the patient's accident, which is the only apparent factor to be considered, occurred five months previously. During the patient's stay in the hospital the hemorrhages in the deep retinal layers have gradually become absorbed and the subchoroidal hemorrhage appears to be traveling downward.

DISCUSSION

DR. FRANCIS ADLER: I believe that the condition is a subdural hemorrhage which came down the sheath of the optic nerve and finally presented itself at the disk. I am particularly interested to know what type of defect might arise in the visual field from such a lesion. It has been thought by some writers that the defect in the visual field in cases of choroiditis juxtapapillaris indicates that the disease involves the sheath of the optic nerve close to the disk and hence gives rise to defects in the nerve fiber bundles. Such defects were not found in the case reported here. The defect in the visual field represented an involvement of a large portion of the retina. It is rather curious how long it took the hemorrhage to make its appearance. As it spread out in the choroid it caused a flat detachment of the choroid and retina. It seems to me the only other diagnostic possibility is that of a tumor in this region, and the eye will have to be carefully watched.

DR. CHARLES B. HEED: Did I understand this lesion to be the result of hemorrhage or of clot?

DR. FRANCIS ADLER: The lesion is definitely composed of blood and is situated in the choroid. There is some fairly fresh blood toward the periphery of the lesion.

RETINAL DETACHMENT TREATED SUCCESSFULLY WITH THE THERMOPHORE: RÉSUMÉ OF FIVE CASES. DR. H. MAXWELL LANGDON.

In September 1934 a patient with detachment of the lower portion of the retina was operated on by means of sclerotomy for drainage of the subretinal fluid. A flap of conjunctiva was laid back and multiple applications of Shahan's thermophore, at a temperature of 165 F., were made into the sclera. The vision afterward was 5/9, with a full visual field, and has remained so for three years.

In November 1935 a patient with detachment of the complete lower half of the retina was similarly treated. The retina had been detached for four months before operation. Central vision was 4/60, and the entire upper visual field was lost. After the operation the corrected vision was 6/30, and the visual field was full. This improvement has been maintained to the present.

In February 1936 a patient was operated on at the Episcopal Hospital, in the service of Dr. Knox. He had a complete detachment of the upper half of the retina, with loss of the entire lower visual field; the central vision was reduced to the counting of fingers. After the operation the vision returned to 6/9, and the visual field was full, conditions which have remained to the present.

In June 1936, through the courtesy of Dr. H. L. Harley, a patient was seen with a detachment of the temporal portion of the right retina. Central vision was 3/60, and the nasal portion of the visual field was lost. Operation was performed on June 22, with the result that the upper half of the detached portion was replaced, but the lower portion was still detached. On July 2 the lower portion of the eye was again operated on; the retina, however, still remained detached. Central vision was not improved, but the lower portion of the nasal field was restored.

On March 8, 1937, Mr. D. G. H. was operated on for a detachment of the lower outer portion of the left retina, central vision being reduced to 5/15 and the nasal half of the visual field being lost. The operation resulted in a vision of 5/6 partly and a full field.

The operative results of 1 of these 5 cases have been successful for three years, in 1 for two years, in 1 for twenty-two months and in 1 for six months, while those in 1 case were unsuccessful.

Dr. Shahan has operated on a patient in this way, applying the heat first and performing sclerotomy afterward in order to maintain the intraocular tension while using the thermophore and also because heat applied to the sclera at 165 F. had been found to destroy the retinal cell elements. I have not found it difficult to use the thermophore after sclerotomy. I do not see how destruction of some of the retinal cells can be avoided, if there is sufficient reaction to throw out enough exudate to produce adherence of the retina to the choroid.

Dr. John Green has used the thermophore at 153 F. after making three trephine holes in the sclera. If this temperature is sufficient to bring about a choroidal reaction, it should be used rather than the higher temperature which I have used. The trephining seems to be superfluous, as the heat will readily pass through the sclera and the subretinal fluid may more easily be evacuated by sclerotomy.

The patient should be kept in bed for at least two weeks after operation with both eyes bandaged for a week, as the adhesions should be given sufficient time to organize fully, and stenopeic spectacles should be worn for four weeks more.

DISCUSSION

DR. WARREN S. REESE: Did I understand Dr. Langdon to say these were the only cases in which he has used this procedure?

DR. WILLIAM ZENTMAYER: Did any of the patients have myopia?

DR. H. MAXWELL LANGDON: These are the only cases in which I have used this procedure. The only other cases, to my knowledge, in which it has been used were those of Dr. Shahan and Dr. Green. The fifth patient in this series had only 1 diopter of myopia. I feel that this method would be as efficacious in cases of myopia as any other method.

BUPHTHALMOS WITH NAEVUS FLAMMEUS. DR. CARROLL R. MULLEN.

Naevus flammeus associated with glaucoma is of rare occurrence. About 67 cases have been reported since this condition was first described by Schirmer in 1860.

An excellent and most complete review of the reported cases was presented in 1933 by Dr. Cecil O'Brien and W. C. Porter, of the Uni-

versity of Iowa. More recently, Mehney, of the University of Michigan, covered the known evidence of this condition in reporting an additional case.

It will not be necessary to digest these reviews because the published reports are readily available and remain rather fresh in one's mind from repetition in the past four years. Briefly, it may be pointed out that glaucoma can be looked for in cases of facial nevus which involves the lids, the conjunctiva, the episclera, the iris, the choroid or other ocular structures. It is usually of the infantile type, of which Drs. O'Brien and Porter found 38 instances in their total of 56 known cases. Unilateral glaucoma has been noted in practically all cases. Intracranial changes are often associated with this condition.

T. B., a white woman, aged 22, a native and resident of South Carolina, presented herself at the clinic of Dr. Thomas A. O'Brien at the Wills Hospital during August 1937. She was mentally alert and appeared equal to persons of her age. According to her history, a port wine birth mark and protrusion of the right eye had been present since birth. She never recalled vision being present in this eye, nor did it ever pain her, although she observed that at times it "aches and feels tight."

The patient had three brothers. There was no history of nevi appearing in any member of her family, and none of her immediate relatives had trouble with their eyes. In 1931 or 1932 she received four or five treatments with radium, but no effect on the nevus was observed.

There was no perception of light in the involved right eye. Visual acuity in the left eye was 6/9+4.

The external examination showed a port wine nevus involving the right half of the face, including the eyelids, the nose and the upper lip. The right eyeball was enlarged; it protruded and diverged 30 degrees. Tension of this eye was recorded as 66 mm. of mercury (Schiötz) and checked with two weights. With an exophthalmometer, the position of the right eye measured 35 mm., and that of the left eye, 13 mm. There were some slight upward, downward and lateral excursions of this eye, but it could not rotate medially past its midline. The cornea of the right eye measured 15 mm. in transverse diameter, and that of the left eye, 10 mm. The cornea was conical; the anterior chamber was deep, and the pupil was well dilated and fixed.

External examination showed the left eye to be apparently normal. With the confrontation method, the visual fields were full and normal.

Ophthalmologic study of the right eye showed some central corneal changes and many fine linear, closely packed lenticular opacities, which extended from the periphery of the lens to meet at its center. A red reflex was present, but because of the haze in the media details could not be made out other than that the disk appeared to be pale. Cupping of the disk could not be determined.

Examination of the right eye with the slit lamp showed several small opaque deposits in the center of the cornea and the presence of lenticular opacities. The anterior chamber was deep.

In confirming the diagnosis of *naevus flammeus*, Dr. Joseph V. Klauder stated that in twelve years at the Wills Hospital he had never before observed this condition associated with glaucoma.

unselected cases in which corneal transplantation was the favorable cases in which this procedure was carried out corneal graft was obtained in over 70 per cent, with improvement in vision, varying from perception of hand motion of fingers at from 1 to 4 feet (30 to 122 cm.) before to from 20/200 to 20/20 afterward.

Transplantation, in the present state of knowledge, does not carry a greater operative risk than an operation for cataract. Results obtained with corneal transplantation can be favorably compared with those obtained with other operations universally accepted and practiced by ophthalmic surgeons.

DISCUSSION

DR. ANST. WALDSTEIN: May I ask whether corneal grafting is more likely to produce better results in some conditions than in others? Castroviejo and his associates found that this procedure gives better results in cases of corneal opacity following parenchymatous keratitis than in cases of opacity following, say, a burn of the cornea?

DR. MON. CASTROVIEJO: When a transplant is to be entirely successful, dense scar tissue, the transplant seldom remains transparent. It usually becomes either nebulous or opaque.

A corneal transplant remains transparent in a high percentage of cases of parenchymatous keratitis, in which as a rule a good deal of normal corneal tissue is preserved.

Corneal leukoma following a burn from lime or similar types is usually generally unfavorable for keratoplasty, on account of the density of the leukoma and the presence of superficial blood vessels resembling those observed in cases of severe trachomatous keratitis. A preliminary operation should be performed to remove the leukoma from the cornea. Otherwise, the transplant becomes either opaque or nebulous.

MELOMELANOMA OF THE IRIS: REPORT OF A CASE. DR. BERNARD

A 77-year-old man complained of decreasing vision for a year and recent blindness of the right eye. The eye was blind. Transillumination gave a negative result. Enucleation failed to keep down the increased intraocular pressure. The eye was enucleated because of pain. Routine pathologic examination showed a melanoma of the iris. The growth recurred 18 months later, exenteration of the orbital contents being performed.

ANOMALY OF THE OPTIC NERVE. DR. FRANK D. CARROLL.

Two cases of the optic nerve are presented:

1. An old woman had a hole on the temporal side of the optic nerve 7 D. in depth. The nerve appeared grayish and the superior temporal artery curved into the hole corresponding to the hole in the papillomacular bundle. The visual field extending almost to the point of the hole.

versity of Iowa. More recently, Mehney, of the University of Michigan, covered the known evidence of this condition in reporting an additional case.

It will not be necessary to digest these reviews because the published reports are readily available and remain rather fresh in one's mind from repetition in the past four years. Briefly, it may be pointed out that glaucoma can be looked for in cases of facial nevus which involves the lids, the conjunctiva, the episclera, the iris, the choroid or other ocular structures. It is usually of the infantile type, of which Drs. O'Brien and Porter found 38 instances in their total of 56 known cases. Unilateral glaucoma has been noted in practically all cases. Intracranial changes are often associated with this condition.

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In confirming the diagnosis of naevus flammeus, Dr. Joseph V. Klauder stated that in twelve years at the Wills Hospital he had never before observed this condition associated with glaucoma.

The roentgenographic examination by Dr. Spackman disclosed the right orbit to be enlarged and slightly deformed. A peculiarity in the formation of the right frontal sinus was noted. He also observed that the general architecture of the skull appeared to show a tendency to congenital deformity. The sella turcica was unusually small and underdeveloped. The optic canals were slightly smaller than usual but equal and symmetrical on the two sides. The sinuses were all clear except the right maxillary sinus, which showed increased density.

Dr. John Reese, on examination of the nose and throat, noted infected tonsils but no clinical evidence of sinusal infection. He believed the nevus responsible for the cloudiness observed in the roentgenogram in some of the cells of the sinuses on the right side. The nevoid process terminated about midway down the posterior pharyngeal wall.

Both the Meinicke and the Wassermann reaction were negative, and the chemical composition of the blood was within normal range.

SUPERFICIAL PUNCTATE KERATITIS: ITS TREATMENT WITH IODINE SOLUTIONS. DR. ALFRED COWAN and DR. THOMAS H. COWAN.

This article appears in full in this issue of the ARCHIVES, page 709.

PAPILLITIS SECONDARY TO IRIDOCYCLITIS. DR. WILFRED E. FRY.

The condition described here represents a type of change in and about the disk associated with severe inflammation of the anterior segment of the eye. Such inflammation may be corneal ulceration, iritis or iridocyclitis. The changes in the anterior segment do not necessarily have to be prolonged, and in this case the inflammation was not of particularly long standing.

The patient, a 78 year old woman, first complained of an inflamed right eye on April 11, 1935. Two days later, when she first consulted a physician, drops were given. Nine days later, when she was first seen by me, there was a large ulcer of the lower inner section of the cornea. She was immediately hospitalized.

The general examination gave negative results except for hypertension (blood pressure, 230 systolic and 100 diastolic) and albuminuria, with a few fine granular casts.

In spite of treatment, consisting of subconjunctival injections of Pregl's solution (the solution resulting from the action of iodine on sodium carbonate solution) as well as local applications and injections of milk intramuscularly, the condition became worse, and the right eye was enucleated on April 29. A section of the eye showed dense corneal infiltration and an area of perforation, which occurred at the time of operation, dense infiltration of the iris, inflammatory occlusion of the pupil, markedly dilated choroidal vessels and a subretinal space into the papilla. The fibers of the lamina cribrosa sclerae retained their normal contour. The retina, except close to the papilla, retained a relatively normal structure.

I believe that this condition is papillitis, although other diagnoses must be considered: first, a choked disk from increased intracranial pressure; second, a choked disk associated with hypertensive retinitis, and third, edema of the papilla from ocular hypotony.

READING DIFFICULTIES IN CHILDREN. DR. GEORGE E. BERNER.

DISCUSSION

GLADYS G. IDE, PH.D.: Dr. Berner has presented the problem of children who have difficulty in reading, the cause of which probably is a defect in vision.

A certain group of children having ocular defects and good mentality are able to make accommodation to visual defects even though these defects may be serious. They will also learn to read even under the most adverse circumstances.

Most children, however, do not have a good enough mentality to be able to learn to read with a bad visual defect. The need for accommodation is not recognized, and the child fails because he does not know how to make use of his poor visual equipment to the best advantage. Neither will he try, as I have seen a child try, to accommodate when an appreciable amount of time is required for him to focus his hyperopic eyes on a stimulus. Few children can endure the strain or discover for themselves what must be done in order to secure a definite image. The plea which the educator makes to the ophthalmologist is on behalf of those children who must be adjusted to the school requirements and who are unable to meet these requirements because of poor vision. About 10 per cent of the ordinary dull children entering school are unable to profit by school instruction in reading because of poor vision.

DR. WILLIAM ZENTMAYER: Would it be feasible, advisable or useful to have the lines printed alternately from left to right and right to left?

DR. GEORGE E. BERNER: The printing of lines in alternate directions has been done, not, I believe, for the teaching of reading but as an experiment to see if good readers would receive any benefit in the way of more rapid reading and relief from eyestrain. What the results were, I do not know, but certainly it would be a method adaptable only to a person with an extremely wide range of visual attention and could never be used for the ordinary "newspaper type" of reader.

NEW YORK ACADEMY OF MEDICINE, SECTION
OF OPHTHALMOLOGY

JAMES W. WHITE, M.D., *Chairman*

Oct. 18, 1937

RUDOLF AEBLI, M.D., *Secretary*

RESULTS OF CORNEAL TRANSPLANTATION. DR. RAMON CASTROVIEJO.

More than 100 corneal transplantations have been performed during the past four years at the Institute of Ophthalmology, Medical Center.

The shape of the transplant as well as different steps of the technic have been altered repeatedly in order to find the procedure which would give the best results in the highest percentage of cases. Occasionally modifications of the technic had to be introduced to suit particular instances. Marked improvement in vision was obtained in over 40

per cent of the unselected cases in which corneal transplantation was performed. Of the favorable cases in which this procedure was carried out, a transparent corneal graft was obtained in over 70 per cent, with marked improvement in vision, varying from perception of hand motion to the counting of fingers at from 1 to 4 feet (30 to 122 cm.) before the operation to from 20/200 to 20/20 afterward.

Corneal transplantation, in the present state of knowledge, does not offer a much greater operative risk than an operation for cataract. The results obtained with corneal transplantation can be favorably compared with those obtained with other operations universally accepted and routinely practiced by ophthalmic surgeons.

DISCUSSION

DR. ERNST WALDSTEIN: May I ask whether corneal grafting is more likely to produce better results in some conditions than in others? Have Dr. Castroviejo and his associates found that this procedure gives better results in cases of corneal opacity following parenchymatous interstitial keratitis than in cases of opacity following, say, a burn from lime?

DR. RAMON CASTROVIEJO: When a transplant is to be entirely surrounded by dense scar tissue, the transplant seldom remains transparent. It generally becomes either nebulous or opaque.

The transplant remains transparent in a high percentage of cases of parenchymatous keratitis, in which as a rule a good deal of normal or almost normal corneal tissue is preserved.

A corneal leukoma following a burn from lime or similar types of injury is generally unfavorable for keratoplasty, on account of the extreme density of the leukoma and the presence of superficial blood vessels, resembling those observed in cases of severe trachomatous pannus. A preliminary operation should be performed to remove the vessels from the cornea. Otherwise, the transplant becomes either nebulous or opaque.

MELANOSARCOMA OF THE IRIS: REPORT OF A CASE. DR. BERNARD FREAD.

A man aged 77 complained of decreasing vision for a year and recent pain in the right eye. The eye was blind. Transillumination gave a normal picture. Iridectomy failed to keep down the increased intraocular pressure, and the eye was enucleated because of pain. Routine pathologic examination revealed melanosarcoma of the iris. The growth recurred in the orbit ten months later, exenteration of the orbital contents being necessary.

LESIONS OF THE OPTIC NERVE. DR. FRANK D. CARROLL.

Three cases of lesions of the optic nerve are presented:

CASE 1.—A 65 year old woman had a hole on the temporal side of the optic nerve about 7 D. in depth. The nerve appeared grayish white. A small branch of the superior temporal artery curved into the hole and out again. Corresponding to the hole in the papillomacular bundle there was a defect in the visual field extending almost to the point

of fixation. The visual acuity was 20/30, and opacities of the lens were sufficient to account for this reduction in vision. Below the disk in the area sometimes occupied by coloboma of choroid there was a marked pigmentary disturbance, with a corresponding defect in the upper part of the visual field. The fundus of the other eye was normal.

CASE 2.—A patient with Leber's disease belonged to a family in which at least 6 other members had the same condition. The age of onset in this group varied from infancy to past middle age, and the visual acuity, from 20/50 in each eye to almost blindness.

CASE 3.—A woman aged 22 had sudden loss of vision in one eye, so that she could see only hand movements. The margins of the disk were slightly blurred in that eye. In one month the visual acuity and the visual fields were normal without any treatment. Four years later she had a similar attack in the other eye, which cleared up without treatment in ten days. Neurologic examination indicated probable multiple sclerosis. When one attempts to evaluate some newly suggested treatment which is supposed to hasten the speed of recovery in such cases, it is well to remember the normal course of the disease without treatment.

DISCUSSION

DR. ARNOLD KNAPP: When was the visual disturbance discovered in Dr. Carroll's first case, and has it remained stationary?

DR. RAMON CASTROVIEJO: Since Dr. Carroll has been so greatly interested in the study of lesions of the optic nerve, perhaps he has had some experience with the treatment recently advocated by Lauber for atrophy of the optic nerve.

Lauber claims that improvement is obtained in such cases by raising the arterial blood pressure and lowering the intraocular tension by the instillation of myotics.

Dr. Arruga recently reported some cases in which great improvement followed the treatment advocated by Lauber.

I have been treating several patients with atrophy of the optic nerve during the past few months according to Lauber's suggestions, but so far there has not been any improvement, either in the ophthalmoscopic appearance or in the vision.

Since Dr. Carroll stated that in some cases lesions of the optic nerve improve without treatment, perhaps the improvement observed in some of the cases in which Lauber's method has been used could be attributed to the normal evolution of the condition and not to the treatment itself.

DR. WALTER F. DUGGAN: I have treated several patients with frank atrophy of the optic nerve. The only one I particularly recall was a man aged 27 with multiple sclerosis, who said that the vision of his right eye had been poor for three years. The vision was 20/100—, and he had a definite paracentral scotoma with a sloping edge. I prescribed intravenous injections of a solution of sodium nitrite and assumed that he would have from six to twelve doses, and then if he showed no improvement that the therapy would be stopped. I was away from the clinic for a considerable length of time, and when I returned I found that he had received thirty injections; after the fourteenth injection his vision had improved to 20/50. The final vision was 20/30—, which

was maintained for a year after treatment. This is an example of marked improvement in a case of atrophy of the optic nerve. I think that the improvement was due to the fact that the scotoma was small and had a sloping edge. I am certain that the treatment improved the vision, because the patient gave a history of having had poor vision for three years before he was treated. This treatment of atrophy of the optic nerve is diametrically opposite to Lauber's treatment, since the blood pressure is lowered instead of raised.

DR. FRANK D. CARROLL: The patient in case 1 did not complain of disturbance of vision in the eye which had the hole in the optic disk. She was unaware of the defect in the visual field. She complained only of disturbance of vision in the other eye, which had the cataract. The visual acuity in the eye with the hole in the optic disk was 20/30. In looking over the literature, I found that in most of the cases there was no defect in the visual field corresponding to the hole and that most of the patients had good vision. Some of them, however, did have defects in the visual field, as occurred in the case reported by me. Holes sometimes occur in patients who have a frank coloboma of the disk, and I assume that this condition is much the same.

In reply to Dr. Castroviejo, I have treated only a few patients by the method suggested by Lauber. However, I have treated them a little differently; in cases of bilateral lesions I have employed miotics in only one eye, using the other eye more or less as a control. I have not seen any difference in the improvement in either eye.

MIXED TUMOR OF THE LACRIMAL GLAND. DR. RICHARD T. PATON.

A white man aged 22 had had an intermittent swelling of the left upper lid for a year. There had been convergent strabismus and amblyopia of one eye since childhood. The eye on the side of the tumor showed a flat detachment of the retina, which receded after removal. Strabismus was corrected one year later. There was no recurrence of the tumor after three years.

DISCUSSION

DR. ALGERNON B. REESE: The detachment of the retina in Dr. Paton's case is a most unusual complication. I wonder if it could have been due to an indentation of the sclera by the tumor. An orbital tumor sometimes pushes the sclera in, rather than the eye out. This would account for the slight amount of exophthalmos present.

DR. ARNOLD KNAPP: Pressure on the eyeball by an orbital tumor, as described by Dr. Paton, is a symptom described by Dimmer some years ago in his book on ophthalmoscopy. It is particularly pressure which is exerted literally on the eyeball, so that the eyeball cannot elude it, which causes a depression of the sclera, with detachment of the choroid and the characteristic wrinkling of the retina.

DR. DAVID WEXLER: Mixed tumors containing the elements which were reported in Dr. Paton's case may be highly malignant. Several years ago Dr. Isadore Goldstein and I reported a case of proptosis in a young man which was caused by a mass arising from the great wing of the sphenoid (Tumor of the Orbit in a Case of Osteochondrofibrosarcomatosis, ARCH. OPHTH. 21:201 [Aug.] 1934). The tumor

was a rapidly growing fibrosarcoma, containing, in addition, immature cartilage and bone. However, it was but one of numerous malignant growths arising from various parts of the skeleton (sternum, ribs, vertebrae, pelvis and skull) and resulting in death. Tissues in the tumor were embryonal and probably resulted from sudden growth of the undifferentiated elements in various areas.

DR. RICHARD T. PATON: In answer to Dr. Reese's suggestion that the detachment was due to pressure, I think that is correct.

ADIE'S SYNDROME. DRS. FOSTER KENNEDY, HERMAN WORTIS, JOHN REICHARDT and BAXTER B. FAIR.

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ROYAL SOCIETY OF MEDICINE, SECTION OF OPHTHALMOLOGY

London, England, Nov. 12, 1937

MR. W. H. McMULLEN, O.B.E., F.R.C.S., *President*

PLASMOCYTOMA OF THE LACRIMAL GLANDS. MR. S. T. PARKER, F.R.C.S.

Plasmocytoma of the lacrimal gland is rare. A report of the case on which this presentation is based follows: A man aged 66 sought advice because he and his friends noticed that his left eye appeared to be gradually closing. This had been first observed ten months previously. Examination disclosed ptosis and some undue prominence in the outer half of the supraocular sulcus. The marginal portion only of the upper eyelid was capable of slight voluntary movement. On digital examination there was revealed a firm, somewhat lobulated subcutaneous swelling, which seemed to be extending from the fossa for the lacrimal gland. All the ocular movements were free; there was no diplopia; vision was 6/6 unaided, and the fundi and media were apparently normal. Tumor of the lacrimal gland seemed to be the most likely diagnosis; this was confirmed at operation a few days later. The lacrimal gland, which was enlarged to about two and a half times its normal size, was removed without great difficulty. It was grayish brown, slightly lobulated, firm and encapsulated. At one point the capsule was thin and seemed torn. The bony upper wall of the orbit appeared to be normal, and a portion of gland seemed to remain. The patient made an uneventful recovery.

Microscopically, the tumor was found to be a cellular nodule of tissue, and there was a definite attempt at encapsulation by means of fibrous connective tissue. Fibrous tissue trabeculae, many of them thick and solid, entered the substance of the nodule from this capsule and, intersecting in the substance, divided it into lobules. Many well formed blood vessels accompanied these septums, but few were seen in or among the actual masses of tumor cells. No areas of degeneration or necrosis were seen. The cells were indistinguishable from plasma cells. They

had undergone slight distortion as a result of fixation but were, roughly, oval or circular. The cytoplasm of the cells appeared amorphous. One or two nucleoli were to be seen in most of the nuclei. Mitotic figures were scarce. Underneath, the tumor was a plasmocytoma.

For the first six months after the operation no sign of recurrence was detected, and the patient resumed his normal life, that of a farmer. Gradually the inner half of the supraocular sulcus became obliterated by a second swelling, of similar size and consistency. After a year, another new growth, slightly less in size than the first, was removed. This was adherent to the frontal bone, with some erosion of the floor of the frontal sinus. After the removal of the mass, the surrounding area was cauterized freely by means of diathermy. A good recovery ensued, but the patient suffered from troublesome diplopia, on account of the damage to the superior oblique muscle. As a number of observers have noticed good results from the application of radium, this form of therapy was used six weeks after the second operation, and no further recurrence was noticed until the lapse of eleven months. In July 1937 a tumor as large as that first observed was seen, and again radium was tried, the needles being inserted more deeply. There has been no recurrence so far. The rest of the skull, long bones, spine, ribs and sternum appeared normal. The Wassermann reaction was negative. Tests of the urine, especially the Bence Jones albumose test, gave negative results, and the blood was normal.

In the past the term plasmocytoma has been used to describe any form of tumor, either neoplastic or inflammatory, which was composed of plasma cells. The distinctive features of the plasma cell, as seen under the microscope, are: a large cell (up to three times the size of a lymphocyte), either oval or polyhedral. The cytoplasm is clear and seems to take more of the stain peripherally. The nucleus is eccentrically placed, with deep basophilic staining of its chromatin content, radiating in cartwheel form and condensed beneath the nuclear membrane. The size of the nucleus varies. A clear crescentic perinuclear zone in the cytoplasm is definitely demonstrated by staining with hematoxylin.

The origin of the plasma cell is unknown; many think it arises from a lymphocyte. Another theory is that it originates from fibroblasts, arising in the endothelial lining of the blood vessels.

The condition is rare in females and may appear in a medullary or an extramedullary form. Twelve cases have been described, in which the differential white cell count showed, on the average, 20 per cent of plasma cells. In all, the high percentage of these cells was associated with diffuse infiltration in various parts of the bone marrow of the skeletal system, owing to plasmocytoma. Half the cases of myelomatosis are cases of plasmocytoma.

The facts that the condition is sometimes associated with positive evidence of syphilis or tubercle and that plasma cells have been found in cases of chronic inflammatory conditions have led some observers to consider these tumors of an inflammatory origin.

Any kind of neoplasm of the lacrimal gland is a comparative rarity, but there is a possibility that some neoplasms described as lymphosarcoma are of this nature.

The present knowledge of the histologic picture of this condition, so far as the lacrimal gland is concerned, does not support the theory that plasmocytoma is of lymphocytic origin but is a type of endothelioma.

DISCUSSION

MR. BASIL GRAVES: A patient was admitted to the Royal Westminster Ophthalmic Hospital in 1934 with a history of having had a recurrent tumor along one of the rectus muscles. Operation had been performed at another hospital. The pathologist's report was that the tumor was a plasmocytoma.

BRITISH OPHTHALMOLOGY IN THE SIXTEENTH AND SEVENTEENTH CENTURIES. MR. ARNOLD SORSBY.

In this freely illustrated paper it is sought to deal justly with the authors of earlier works on ophthalmology, and praise is given where it had long been withheld.

DEFECTIVE MOVEMENTS OF THE LEFT EYE. MR. N. RIDLEY (for Mr. Affleck Greeves).

A boy aged 7 years was seen in the outpatient department in February 1937, after he had struck his eye on a door handle four days previously. Since the accident he had had double vision, one image being above the other. After the accident he vomited and had severe headache but did not become unconscious. Vision in this eye was 6/9; that in the right eye was 6/6. There were absence of upward movement and marked limitation of downward movement. Lateral movements were associated with jerkiness, but it was not true nystagmus. Dr. Purdon Martin, a neurologist, thought that the condition was due to a small hemorrhage at the apex of the orbit. No fracture was evident in the roentgenogram. In the last eight months the movements have become almost normal.

DEEP STAIN OF THE CORNEA: ARGYROSIS FROM STRONG PROTEIN SILVER. MR. FRANK JULER.

An engineer aged 24 had a toy pistol explode in his face in August 1936, and he received multiple foreign bodies in each eye. Drops of a 2 per cent solution of strong protein silver were used twice daily in each eye from November 1936 until September 1937. A fortnight ago vision was 6/5 partly in each eye; the eyes are now quiescent, except for a slight conjunctivitis. Examination showed a definite silver staining of the lower parts of the conjunctiva and of the caruncle. There was a metallic fragment in the posterior layers in the 4 o'clock position, which had a glistening, yellow, rusty appearance. In an arc around it was a definite opacity, confined to the posterior layer of closely packed points. These showed a diffuse deep blue color, which was most marked in the parts of the half circle nearest the limbus. The question which arises is whether the blue color is due to the foreign body or to a silver staining associated with superficial argyrosis. There are cases in which argyrosis has involved Descemet's membrane, causing a more or less diffuse blue staining.

MELANOTIC SARCOMA OF THE LIMBUS TREATED BY EXCISION FOLLOWED BY RADIUM THERAPY. MR. E. KEITH LYLE.

A man aged 60 was seen at the hospital in April 1937. Fifty years ago his right eye was splashed with hot fat; this left an opacity on the white of the eye. The opacity gradually spread over the front of the eye in the form of a film and interfered with vision; in the last two years it had become larger. On examining the right eye there was visible a large, raised darkly pigmented plaque, extending over the outer half of the cornea, apparently originating from the limbus in the 9 o'clock position. There were numerous distended blood vessels running into the growth in its lower part. The pupil was active, the tension was normal and the fundus and media were normal. The left eye was normal in every respect. In May the growth was excised; it stripped off the cornea easily, but was more adherent in the limbal region. The conjunctiva over the growth in this region was also excised. In June the patient was given a surface application of radium at the Radium Institute, and in September a similar treatment was administered. Microscopic section of the growth showed it to be a melanotic sarcoma of the limbus arising from nevus cells. It was proposed to give the patient one more application of radium.

DISCUSSION

MR. W. H. McMULLEN: This is a particularly good clinical result up to the present.

NEOPLASM OF THE LEFT OPTIC NERVE (?). MR. KEITH LYLE.

A woman aged 50 was first admitted to the hospital in July 1937, with the complaint that nine weeks previously she commenced to see double. This lasted for thirty-six hours, the two images being seen side by side. Then the left eye became painful, with pain radiating over the left side of the head, down the left side of the nose and into the upper lip. A gradual deterioration in the sight of the left eye ensued, until complete blindness resulted. In 1922 she had undergone salpingo-oophorectomy on account of an ovarian cyst on the right side. Five years later she had pelvic peritonitis, and three years after that colpoperineorrhaphy and subtotal hysterectomy were performed, but there was no evidence of the presence of a neoplasm of the uterus. Examination for the cause of the present complaint showed that the pupil of the right eye reacted briskly to direct light but was consensually inactive. The optic fundus and the visual fields were normal. There was pallor of the left optic disk, the eye was painful to pressure and on movements, and there was a restriction of these movements laterally. There were slight ptosis and proptosis of the left eye. Roentgenographic examination disclosed nothing abnormal in the skull and the orbits. Expert examination of the nasal sinuses, throat and ears gave negative results. The Wassermann reaction of the blood was negative. The blood count showed: red cells, 4,700,000; hemoglobin, 90 per cent; white cells, 7,000; polymorphonuclears, 62 per cent; lymphocytes, 31 per cent, and eosinophils, 1 per cent.

DISCUSSION

MR. L. H. SAVIN: The late James Collier described under the title of inflammatory periostitis in the sphenoid fissure a condition which seems similar to the condition reported here, and at a meeting of the neurologic section of this society he presented a number of cases. The condition reported by Mr. Lyle may possibly be of the same nature.

MR. KEITH LYLE: At no time did this patient show evidence of inflammation, and there was never any chemosis. Pain is difficult to evaluate. The patient's daughter thinks that her mother makes the most of her symptoms, and perhaps the pain was not so severe as one was led to believe. The complete loss of vision in that eye suggests a lesion inside the optic nerve or a lesion which has led to complete destruction of that nerve.

DETACHMENT OF THE INTERNAL LIMITING MEMBRANE OF THE RETINA.

MR. T. G. FENTON.

A woman aged 23 in February 1937 had an attack of acute juxta-papillary choroidoretinitis, for which no extraocular cause could be found. At the last examination the condition had reached a quiescent stage. There was an atrophic area of retina above and on the temporal side of the optic disk, with a corresponding wedge-shaped defect in the lower portion of the nasal visual field. The internal limiting membrane of the retina had become detached and lay in the vitreous close to the posterior surface of the lens, appearing as a thin, transparent membrane, with a round perforation representing the deficiency of this membrane at the optic disk.

DISCUSSION

DR. A. J. BALLANTYNE, Glasgow, Scotland: It is difficult to understand the internal limiting membranes, coming forward, as in this case, in a comparatively healthy vitreous. When the ophthalmoscope was focused on the summit of this membrane there was no surface reflex, but if one focused through it to the retinal details behind, there was the usual retinal surface reflex, which is supposed to come from the anterior limiting membrane.

MR. EUGENE WOLFF: This condition is what is usually described as detachment of the hyaloid membrane. In pathologic conditions, I have seen the membrane even at the back of the lens.

MR. RANSOM PICKARD: I have difficulty in accepting this membrane as the internal limiting membrane, because allowing for the hole corresponding to the disk it does not appear as uniform as one would expect it to be. I think that if the acute condition is a parachoroidal inflammation there would be opacities of the vitreous.

FILARIA BANCROFTI IN THE INTERIOR OF THE EYE. MR. McMULLEN.

A man aged 25, an Indian student, was first seen on Sept. 8, 1937, on account of an inflammation in the left eye of six days' duration. At that time he was being treated by roentgen irradiation for spondylitis, from which he had been suffering intermittently since he was 10 years old. No definite cause for that trouble has been found. A year previously he had inflammation of the left eye, which was diagnosed as iritis; this

lasted for fourteen days. When the patient was seen by me the eye was much injected and the aqueous was slightly cloudy, with many floating particles. The pupil dilated well with atropine. The patient suffered from intense pain, and treatment with leeches was ineffective. During examination with the slit lamp there suddenly came into view in the aqueous a minute wormlike object, actively motile and thin. After a few seconds it disappeared. In October the signs of inflammation had almost subsided, but the slit lamp again showed a nematode worm. Colonel Wright examined the patient and agreed that it was a worm. The patient was admitted into the Hospital for Tropical Diseases, under the care of Dr. Cruickshank, who reported that microfilarias (*Filaria bancrofti*) were present in the night blood in fair numbers. The cutaneous test for filarias gave negative results.

DISCUSSION

MR. T. G. FENTON: I had a similar experience. A patient from West Africa complained of irritation in the eye. One saw a worm $\frac{3}{4}$ inch (1.9 cm.) long wriggling about just above the limbus, under the conjunctiva. After instillation of cocaine hydrochloride into the eye, only the tail end of the worm was seen. The conjunctiva was cut down, and the worm was caught by the tail with difficulty and extracted. After the use of the cocaine, it began to move quickly.

MR. T. HARRISON BUTLER: I published a report of a case of infection with *Loa loa*, in which the appearance was the same as in this case. The patient was a physician from West Africa, and he said that cocaine must not be used, as it would drive the worm away. The worm was 1 inch (2.5 cm.) long.

MR. W. H. McMULLEN: I understand that these subconjunctival filarias are usually *Loa loa*, differing from *Filaria bancrofti*.

 GERMAN OPHTHALMOLOGICAL SOCIETY

Fifty-First Annual Meeting, Heidelberg, July 6-8, 1936

TRANSLATED BY PERCY FRIDENBERG, M.D., NEW YORK

DOCENT DR. MAX BÜCKLERS, TÜBINGEN, *Reporter*

Fifth Scientific Session

Wednesday, July 8, 1936, 3 p. m.

PROF. HANS LAUBER, *Chairman*, WARSAW, POLAND

(Concluded from Page 648)

DIAGNOSIS AND TREATMENT OF PARATHYROID INSUFFICIENCY. DR. FRIEDRICH HOLTZ, Berlin.

Often the typical phenomena of tetany, such as paresthesia and cramps, are missing, and the disturbance is manifest by varying clinical

symptoms. Among them are asthenia; rapid tiring; psychic disturbances; migraine; syncope; typical epileptic attacks; angina pectoris; vasomotor disturbances; a multiplicity of cutaneous changes, such as herpetiform impetigo, and irregularity in defecation. The diagnosis is based on the titer of the serum calcium (normal value, from 9.5 to 11 mg. per hundred cubic centimeters), the response to mechanical stimuli (Chvostek and Trousseau signs) and the response to galvanic current. Lenticular opacities are common (tetany cataract), so that slit lamp examination may give valuable and early evidence for the recognition of parathyroid insufficiency. This is of practical importance, as the systematic administration of irradiated ergosterol brings about relief from all symptoms and makes the patient fully able to go back to work.

INFLUENCE OF IRRADIATED ERGOSTEROL ON EXPERIMENTAL TETANY IN RATS. DOCENT DR. WALTER RAUH, Leipzig.

Irradiated ergosterol has been found by Dr. Holtz to contain a product which, like the parathyroid hormone, induces hypercalcemia and prevents the outbreak of acute tetany and/or cures it if already present. The preliminary report is based on 46 rats which were subjected to operation. Eleven of the animals were given irradiated ergosterol before the operation, and 35, subsequent to it, after a varying interval of time. Tetany developed in all of the 11 rats, and 2 died during the attack. Of the surviving 9 rats, 4 presented typical vacuolar cataract, while 5 showed only punctate cataract, which retrogressed considerably in the course of time. Nineteen of the animals received irradiated ergosterol from sixty-five to forty-eight hours before operation. One died in an acute attack; a slight vacuolar cataract developed in 1, and 17 retained clear lenses. Sixteen of the animals were given irradiated ergosterol from thirty-five to five hours before operation. Vacuolar cataract developed in 2 and punctate cataract in 2, while 12 showed transparent lenses. The animals were kept under observation for from forty-six to thirteen days. These data indicate that irradiated ergosterol given in sufficient and timely doses before extirpation of the parathyroid glands can be relied on to prevent the development of lenticular opacities. Administered shortly after the outbreak of the first spontaneous attack, it will prevent punctate opacities of the lens from developing into vacuoles.

CALCIUM METABOLISM AND THE EYE. PROF. ALOIS MEESMANN, Kiel.

With the aid of irradiated ergosterol, one can accurately regulate the height of the blood calcium in cases of hypofunction of the epithelial bodies. Lenticular changes were noted in 13 of a group of 24 cases of tetany, postoperative as well as genuine. In addition to the well known picture of flattening of the lens in its sagittal diameter, with the development of opacities, which were at first subcapsular, 3 adults showed at an early stage subcapsular spokes (*Reiterchen*) arranged in accordance with the course of the peripheral lamellae of the lens. In the cases of genuine tetany there were found also convincing transitional forms of lenticular opacities in all stages up to true zonular cataract. So far, treatment with irradiated ergosterol in these cases has brought the development of

cataract to a standstill for as long as three years, and it has been necessary to operate in only 2 cases in which the condition was far advanced. The flattening of the lens in its sagittal diameter caused a marked decrease in refraction in 1 case, and at the height of the attack a peculiar visual obscuration of high degree was repeatedly observed without any decided changes being detected ophthalmoscopically. In 2 cases of osteitis fibrosa hypercalcemia caused in an otherwise sound eye an extensive change in the limbus, like the white limbus line, which extended far back into the cornea, and calcification of the sclera, which in 1 case could be studied microscopically. In 1 case of cataract associated with glaucoma and aphakia in one eye and good vision in the other eye an overdose of irradiated ergosterol, taken because of a misunderstanding on the part of the patient, was followed by calcification of the entire lower half of the cornea, which cleared almost completely after the blood calcium had returned to normal. A follow-up study of 32 patients with zonular cataract showed increased irritability to electric stimuli in 69 per cent and dental changes in 56 per cent. According to the current conceptions, these dental changes are due to a lowered function of the epithelial bodies in addition to a deficiency of vitamin D. The calcium level was normal, except in 1 case. In 18 cases of congenital cataract symptoms indicating latent tetany were found only once. In 20 cases of coronary cataract and in 14 of posterior lamellar cataract an increase of irritability to electric stimuli, with otherwise normal findings, was noted with striking frequency, whereas in none of 60 cases of true senile cataract were there indications of latent tetany. In view of the extraordinary differences in the frequency of tetany in various parts of Germany and the practical importance of the treatment of lenticular opacities with irradiated ergosterol, a study of the various forms of cataract should be taken up anew. The general practitioner must become familiar with the early abortive forms of tetany cataract in order to examine patients with such cataracts for evidence of latent tetany and to make use of efficacious treatment with irradiated ergosterol. The protean symptoms of latent tetany often result in the diagnosis being overlooked. Even mild tetany, however, may end fatally in ileus or cardiac tetanus. The cooperation of the ophthalmologist is, accordingly, of essential importance.

DISCUSSION ON

PAPERS BY DR. HOLTZ, DOCENT DR. RAUH and PROFESSOR MEESMANN

DR. ERIK VON BAHR, Uppsala, Sweden: As previously reported, I have been able to produce lenticular opacities of the zonular type in rats by purely dietetic measures which led to rachitic tetany. The only difference in the diet of the rats with uncomplicated rachitis, which did not show lenticular changes, and that of the animals with rachitic tetany, in which lenticular changes developed, was as follows: The calcium-phosphorus ratio of the rachitogenic diet was 4:1; for the rats in which lenticular changes developed it was suddenly altered to 1:1. The result was a lowering of the blood calcium, resulting in some analyses to one-half the normal amount.

On the basis of these experiments it cannot be maintained that a parathyroid insufficiency existed to the extent that there was a reduction

in the production of parathyroid hormone; on the contrary, it appears that hypocalcemia was the cause of the lenticular opacities. These opacities were similar to those seen in cases of parathyroprival tetany. In some cases the little punctate opacities disappeared when the tetany disappeared, but more often they progressed.

PROF. ADOLF JESS, Leipzig: Any one observing a presenile cataract which is at all suggestive of tetany should have the calcium content of the blood determined and a careful neurologic survey made of the patient in order to disclose any latent tetany. A routine examination of this sort would make possible the effective treatment with irradiated ergosterol of a multitude of obscure and inexplicable constitutional disturbances due to insufficiency of the epithelial bodies. Hypocalcemia is common in patients with precocious senile cataract, as are other symptoms of tetany. Treatment with irradiated ergosterol markedly improves the general condition. Early diagnosis is advisable in cases of tetany to determine whether prompt treatment with irradiated ergosterol will cause incipient lenticular opacities to retrogress as they did in the experimental rats.

DR. D. K. PISCHEL, San Francisco: A number of years ago experiments were conducted at Stanford University to determine the influence of dinitrophenol on basal metabolism. A marked rise was noted. Great care was requisite in the administration of the drug, as cases of poisoning by dinitrophenol had been observed as far back as the World War in workers in the manufacture of high explosives. The drug was widely used in California to counteract obesity. Patients like to take it. It creates a pleasant feeling of warmth and mitigates hunger sensation.

A year and a half ago several cases of cataract due to dinitrophenol were seen. In such cases, in a dilated pupil one sees a yellowish green reflex and an opacity in the posterior cortex which looks like a thin shell of copper which has been roughly and irregularly scratched. It would be interesting to know whether this lesion has been seen by my colleagues in Germany. Those who are concerned with these interesting investigations of the chemistry of the lens should include the effect of dinitrophenol on the lens in their list for future study.

DR. H. C. MÜLLER, Basel: In Basel my associates and I up to the present have been unable to produce lenticular opacities, such as those described by Dr. Pischel, by the administration of dinitrophenol. So far, our experiments have been few, and we are inclined to believe that the deleterious action of dinitrophenol on the transparency of the lens is due to its causing increased oxidation.

PROF. WALTER LÖHLEIN, Berlin: Dinitrophenol is little used for the cure of obesity in Germany, as physicians have been warned of its dangers by reports published abroad of the development of cataract following its use. However, Vannas, of Helsingfors, recently published a report of a number of cases of cataract due to a dinitrophenol reducing diet.

PROF. JOHANNES OHM, Bottrop: In several cases of eczema due to an idiosyncrasy for scopolamine the administration of calcium relieved the cutaneous condition, although the instillation of scopolamine for the purpose of dilating the pupil did not have to be discontinued.

DOCENT DR. MAX BÜCKLERS, Tübingen: One must distinguish sharply between postoperative cataracta strumipriva (sic [parathyreoopriva? P. H. F.]) seu tetanica on the one hand and zonular cataract on the other hand, which it is claimed develops on a basis of spasmophilia in infants. Only a few of the pictures shown by Professor Meesmann convinced me that he was dealing with true zonular cataract. In this condition one invariably notes a uniformly opaque surface or area in addition to the isolated spokes shown here. It is true that these scattered opacities are located in a zone, viz., a discontinuity layer, but for all that they do not constitute a true zonular cataract.

PROF. ALOIS MESSMANN, Kiel: The fact that in a number of cases of postoperative tetany the lenticular opacities began in the form of subcapsular spokes would indicate that similar changes in the lens consisting exclusively of spokes are due to tetany. It certainly compels one to watch for other tetanic symptoms.

OPERATIVE TREATMENT OF GLAUCOMA. DR. E. MÜGGE, Eisleben.

Thirteen glaucomatous eyes were operated on by passing a fine diathermy needle through the ciliary body and into the posterior chamber at three or four points. The result was invariably a negative one, in contradistinction to the good results claimed by Skokolik for his ignipunctures. This proves the correctness of Sondermann's conviction of the prime importance of a normally functioning ciliary body in cases of glaucoma. His theory is that the success of operations for glaucoma practiced up to the present has been due in part to the development at the site of operation of blood vessels connecting the ciliary body and the episclera. A combination of posterior trephining and cyclodialysis, as was also suggested by Sallmann, seems to be a suitable procedure. Meller's objection that the trephine opening is closed by a cicatrix is invalidated by the fact that it is still possible for the aforementioned connecting vessels to form. The opening of the iridocorneal angle is another factor in the improved drainage with this combined operation. In 9 glaucomatous eyes on which this type of operation was used the tension was completely reduced to normal, as opposed to 1 failure, although the patients have been followed for only five months. In 1 case in particular repeated trephining by the method of Elliot had been done, with no result. This operation always carries with it the hazard of a rapid progress of any lenticular opacities which may be present. There is less danger of this complication and also less danger of post-operative infection with the new procedure, which is in addition technically simple. That the effect of the operation increases, even after weeks, seems to make logical the assumption of a new growth of ciliary vessels. The function of the ciliary body has a decided significance in the compensation of chronic glaucoma.

DISCUSSION

PROF. KARL LINDNER, Vienna: My associates and I use the Sallmann operation as a routine practice, and I believe that it works better than ordinary cyclodialysis. My explanation for its success is, however, a different one. In a fistulized eye there ensues a contraction of the normal vitreous and, with it detachment of the choroid; this tends

to keep patent a filtration space (*Spaltraum*) between the anterior chamber and the suprachoroidal space.

DR. E. MÜGGE, Eiseleben: In a patient with increased intraocular tension in each eye of about equal amount I got a much better result in the eye which I had operated on by the combined method than in the one on which simple cyclodialysis was performed.

MODE OF ACTION OF SOME MEDICATIONS WHICH REDUCE INTRAOCULAR TENSION. PROF. HANS SCHMELZER, Erlangen.

Experimental study of the effect of miotics and other substances by means of the so-called Nadi reaction (tissue-cell-oxidase reaction) and histologic examination of rabbits' eyes were carried out in collaboration with Pfeuffer and Winkelmann. The drugs tested were physostigmine salicylate, pilocarpine, epinephrine, atropine, scopolamine hydrobromide, cocaine hydrochloride, nervocidine and erythrophleine in the usual clinical concentrations, physiologic solution of sodium chloride and various dilutions of molar (according to molecular weight in grams) potassium cyanide. After injection of these drugs into the vitreous there was generally a decided diminution in the indophenol staining reaction of the ciliary epithelium and of the muscles in the anterior section of the globe with more or less marked inflammatory reaction, when the Nadi reaction was applied. After subconjunctival injection of the same drugs there was only occasionally a slightly fainter blue staining reaction and slight, or no, inflammatory changes in the intraocular tissues. After repeated instillations, the indophenol staining reaction remained practically always normal, and only occasionally were slight inflammatory changes noted in the iris and ciliary body. All drugs which lower intraocular tension have a toxic effect on the capillaries and this plays an important role. This study also suggests that the toxic effect may be associated with a direct or secondary lesion of the ciliary epithelium. However, in the case of pilocarpine and physostigmine salicylate, the pupillomotor factor is by far the most prominent.

DISCUSSION

PROF. KARL LINDNER, Vienna: I wish to call attention to the fact that all mechanical procedures involving the vitreous are associated with alteration of its volume, and this must be taken into consideration in any study and interpretation of the problem of glaucoma.

THE PROBLEM OF COLOR ASTHENOPIA. DOCENT DR. KARL VELHAGEN JR., Halle.

A factor of error on the part of the subject enters into tests for color blindness. Normal subjects can be made to give the impression of a color anomaly in three ways: (1) by prolonging the period of observation with the anomaloscope to the point of fatigue; (2) by conducting the examination when the patient is generally physically fatigued and (3) by placing the patient in a chamber with reduced atmospheric pressure, i. e., one in which the oxygen is withdrawn. Administrative agencies and official boards would like definite information on some practical matters concerning persons with color asthenopia.

Is a subject who has been found by ordinary tests to be capable of correct color perception to be allowed to offer fatigue as an excuse for mistakes in recognition of colors? Is an old employee who has shown himself capable and reliable from this standpoint throughout years of service to be discharged if the tests show color asthenopia? I carried out an extensive series of drastic practical tests on an aviator with color asthenopia (*Klin. Monatsbl. f. Augenh.* 96:442, 1936) who passed them with ease. One's decisions must be subjective and include a consideration of the data of tests with various pigments and with the anomaloscope. A person with mild color asthenopia should not be rejected, and one with severe asthenopia should not be accepted. As a general rule the person should be rejected who shows an increased color contrast, whose readjustment time (*Umstimmung*) is short and whose color accommodation time (*Einstellung*) is decidedly above the so-called anomaly equations. The person who makes any really gross errors or many slight ones during the color tests with pigments and who feels quite sure of himself with his false color matchings (*Fehleinstellungen*) should also be rejected. A person already in service should be excluded only in case of crass errors. My experience, especially with color asthenopia due to anoxemia, indicates that an apparently normal subject may show what looks like a pathologically altered color perception under certain conditions. In medicolegal cases one must inquire carefully first of all whether such adverse conditions were actually present or perhaps were merely alleged as an alibi for the patient. The chamber with reduced atmospheric pressure may perhaps be used as a diagnostic aid. The more uncontrollable factors of error one gets to know, the more one must urge that the color signal system, even if it cannot be abolished, should certainly not be extended and applied to other new purposes.

CONGENITAL LYMPHANGIOMA OF THE ORBIT AND FACE AT VARIOUS AGES. PROF. ADOLF JESS, Leipzig.

(This presentation included a demonstration of colored photographs and photomicrographs made in 3 cases of protrusion of the eyeball and secondary hemorrhages into lymphangiomata).

This condition is exceedingly rare, only 23 cases having been reported in the literature up to the present time. Three patients, aged 6 months, 1 year and 9 months and 30 years, respectively, presented the general clinical picture which is described here. On the basis of an abiogenesis the subjects show at birth a definite hypertrophy of one side of the face, generally the left, which is caused by the abnormal formation of lymph vessels. The orbital tissues are involved, and their increase in volume leads to marked proptosis. The lids and conjunctiva present large and small lymphangiomas, which show as clear cysts beneath the skin and mucous membrane. Areas of netlike lymphangiectasis may be seen under the bulbar conjunctiva. In 1 case similar formations were noted in the tissue of the iris. The tumor of lymph vessels spreads over the forehead, stopping at the midline, and advances through the cheek, the lips and the subcutaneous cellular tissue to the chin, pushing the nose to one side and depressing the angle of the mouth. The buccal mucous membrane, the gums and the hard and soft palate may be thickened by lymphangiomatous proliferations and sown with numerous small lymph

vessels. At various periods of life this process is repeated and by pressure on the globe and nerve causes lesions of the optic nerve and exophthalmos with diplopia. It also causes thickening of the lips, the forehead and the cheeks, which may become still more marked as a result of secondary hemorrhages into the lymph spaces from thin-walled blood vessels. Traumatism may cause superficial blood-filled lymph spaces to burst and present as hemorrhagic effusions in the conjunctival sac or in the buccal cavity. It is a question how far the formation of hemangiomas is concerned in this process, although the clinical as well as the histologic picture is suggestive. The only possible treatment consists in early successive excisions, which at once show, by the escape of water-clear fluid from the tissues, the lymph-angiomatous nature of the neoplastic formation. Perhaps if sufficiently dense scars are produced one may be able to prevent or lessen the incidence of transitory swellings and pressure on important organs, especially the eye, as well as of secondary hemorrhages. Quite possibly, although this has not been demonstrated, there may be actual tumor formations in addition to these more passive hypertrophies. Persons subject to this congenital anomaly must avoid as far as possible injuries of the diseased side of the head, general body shock, as in athletics, and any rush of blood to the head which would increase the hazards of the condition by secondary hemorrhage.

CIRROSITAS VASORUM RETINAE. DOCENT DR. MAX BÜCKLERS,
Tübingen.

A man 28 years of age complained of sudden decrease in vision. Ophthalmoscopic examination revealed diffuse edema of the retina, which had resulted, among other things, in a honey-comb (*Bienenwabenmacula*) macula. In addition, there were visible in the periphery groups of miliary aneurysms and extremely fine capillary loops, ectatic in places. In the course of time the edema cleared and local hemorrhages appeared, some of which extended somewhat into the vitreous. There were no connective tissue sheaths (*Einscheidungen*) along the blood vessels, but spastic contractions at various points of the veins produced a rosary-like or sausage-link-like ("*Kettenwurst*") appearance. The general medical and neurologic examinations gave negative results. There was no evidence of syphilis or tuberculosis. The capillaries at other points of the body were microscopically normal. It was assumed that this condition was an early stage of a disease that was first described by Leber, characterized by retinal infiltrations with miliary aneurysms. The clinical picture speaks in favor of a serious vasomotor neurosis, which up to the time of examination had remained localized, affecting only the retinal vessels. The question is raised whether or not the condition may later develop into massive exudation into the retina (Coats' disease).

CLINICAL STUDY OF THE VESSEL CALIBER IN THE FUNDUS OCULI.
DOCENT DR. E. LOBECK, Jena.

The retinal vessels in a large number of normal and pathologic eyes were measured. The apparatus used was one made from my plans by Zeiss and previously described at the Heidelberg congress of 1934. It

allows one to measure the caliber of retinal vessels and, simultaneously, the diameter of the disk in a short time, one or two minutes, without having to dilate the pupil. The measurements are carried out in accordance with the so-called heliometer principle and give relative values which are read off in the number of scale divisions calibrated on the apparatus. The simultaneous measurement of vessels and disk under identical conditions of optical adjustment (*Einstellung*) allows one to draw conclusions at once as to their reciprocal relations as well as to those between the retinal arteries and the retinal veins. Thus one may judge quantitatively whether one is dealing with vessels of normal caliber, or whether they are dilated or contracted. In addition, the figures can be made absolute if in the ratio of the diameter of the retinal vessels and the papillary diameter one substitutes the figure 1.5 mm. for the latter, which, as is known, is constant irrespective of conditions of refraction. For clinical purposes, however, this is not necessary. In normal eyes the ratio of the diameter of the retinal vessels to the papillary diameter varies from about 1:11 to 1:17, and that of the diameter of the retinal arteries to the diameter of the retinal veins from about 1:1.25 to 1:1.40. In pathologic eyes both sets of relations may be disturbed. The pathologic conditions include local vascular changes, spasms, thrombosis of the central retinal vein or of a branch, angiomatosis of the retina, arteriosclerosis, nephrosclerosis and albuminuric retinitis. The usual alterations noted on ophthalmoscopic examination were confirmed and expressed quantitatively. In cases of arteriosclerosis alterations in the proportion of the diameter of the arteries to that of veins were at times found in the course of one and the same vessel. In cases of nephrosclerosis, albuminuric retinitis and chronic nephritis a high degree of concentration in the arterioles, or precapillaries, was found. The effect of various drugs on the retinal circulation was studied by this method, which is of practical value because it eliminates a factor of error inherent in all those methods which make use of drops to dilate the pupil and necessitates a consideration of the possible action of homatropine and similar mydriatics on the retinal vessels. Tests were made with amyl nitrite, acetylcholine, theophylline with ethylenediamine and choline. The last-mentioned drug definitely dilated the arteries, whereas the first drug apparently has more effect on the veins. The reactions following the administration of caffeine were even more complicated. All these measurements may be useful in evaluating the effect of treatment of disturbances of the retinal circulation and, for the internist, in the pathologic study of renal disease and "pale" and "red" hypertension.

PERIARTERITIS NODOSA (TUBERCULOSA) OF THE RETINA. PROF.
WERNER KRYRIEELS, Hamburg.

Two cases of my own and 2 reported by other observers are presented. In 1, the condition followed tuberculous iridocyclitis. I am of the opinion that the circumscribed changes in the walls of vessels at the posterior pole are caused by toxins which diffuse through the vitreous from an original inflammatory focus in the uveal tract, penetrate the walls of the vessels and cause a reaction with the protective products of the blood stream. In this pathologic process the nature of the inciting agent, or noxa, is of relatively minor importance.

PRESERVATION OF EYEDROPS WITH THE ESTERS OF *p*-OXYBENZOIC ACID.
DR. FRITZ BOCK, Giessen.

The esters of *p*-oxybenzoic acid are widely used in a 0.08 per cent solution for the preservation of eyedrops. Bacteriologic studies show that this concentration is not sufficient to keep eyedrops permanently sterile. A concentration of at least several hundredths more is requisite.

Executive Session, July 7, 1936

On Tuesday, July 7, the members of the society met in executive session. As the members of the jury to award the Graefe medal had received a number of equally meritorious essays and had not been able to decide on the winner, it was agreed not to award the prize this year. Geheimrat Prof. A. Wagenmann announced, to general regret, his decision to resign from the office of secretary, which he had filled for forty years. The chairman expressed the thanks of the society to Professor Wagenmann for his long, faithful and efficient services. The latter was then elected, amid general applause, honorary member of the German Ophthalmological Society. Professor Engelking was unanimously elected his successor. Geheimrat Prof. E. von Hippel found himself obliged to resign from the Executive Committee because of failing health. Prof. F. Schieck was elected in his place.

Book Reviews

Gegenwartsprobleme der Augenheilkunde. Edited by R. Thiel. Price, 16 marks. Pp. 280, with 164 illustrations, 2 colored plates and 21 tables. Leipzig: Georg Thieme, 1937.

The lectures which were delivered in a postgraduate course held at Frankfurt on the Main in February 1937 are now collected and printed in book form. They aim to give information on new ideas and on the present stage of knowledge pertaining to general subjects of importance to ophthalmologists as well as to ophthalmic problems. Since no specialty can exist independently and must be a part of general medicine, those general subjects were selected which have a direct bearing on ophthalmology.

A consideration of the selection of subjects is interesting, as those presented show the trend in present day ophthalmology in Germany. Most of the papers are on general medical and on neurologic topics and are presented by authorities in their branches. Thus, hypertension, essential and malignant (red or pale), is treated by Volhard from the medical point of view and by Thiel from the ophthalmologic point of view. Lampert writes on physiodietetic therapy in its bearing on ocular disturbances.

The chapter on tumors begins with an article by Fischer-Wasels on the sensitivity of the tumor cells to external injury. Then radiation therapy for tumors of the eye and its adnexa is presented by Holfelder, and Gasteiger discusses the indications for this treatment.

A number of important lectures are devoted to tumors of the brain. Kleist writes on the clinical diagnosis of tumors of the cerebral cortex; Pette, on acute inflammatory diseases of the central nervous system and their action on the optic nerves; Olivecrona, on meningiomas of the ethmoid plate; Albrecht, on roentgen diagnosis and treatment of tumors of the brain; Peiper, on the present status of the operative treatment of tumors of the brain with special consideration of the intrasellar and parasellar tumors, and Thiel, on the responsibility of the oculist in the diagnosis and treatment of tumors of the brain.

Bethe writes on the vision of animals without a cerebral cortex and of human beings with disturbed visual cortex; Metzger, on vision for figures and things and the problem of soul blindness; Weigel, on lighting and the oculist, and Jaensch, on the oculist and schools of vision without glasses (Bates).

A series of papers on focal infections are most timely. Gasteiger takes up the role of focal infection in the development of inflammatory diseases of the uvea and of the optic nerve; Voss, the relation of diseases of the tonsils and accessory sinuses to diseases of the eye and of the optic nerve, and Kern, infections of the teeth and jaws as cause for diseases of the eye.

A chapter on ocular paralyses is contributed by Jaensch. Thiel writes on errors in the examination and treatment of glaucoma and on new methods of treatment in ophthalmology.

In the final chapters Felix describes the action of war gases on the eyes; Schlossmacher describes accident insurance from the ocular standpoint, and Gasteiger discusses compensation problems and eugenics.

The reader will find the selection of subjects in this book to be excellent and unusual, quite different from those usually given in the average postgraduate course. The main subjects are: (1) the question of hypertonia, (2) roentgen treatment of tumors, (3) tumors and certain inflammatory diseases of the brain, their treatment with the roentgen rays and by operation and (4) focal infections in diseases of the eye. These are today the subjects of general interest and study. The book also contains a number of important ophthalmic topics.

Professor Thiel is to be congratulated on the selection of the subject matter and on the choice of authoritative collaboration in the presentation of many important borderline subjects. This collection of essays shows that the development of ophthalmology is along the lines of a closer relationship to other branches of medicine. Every ophthalmologist will welcome the appearance of this book and will find its study of great interest and benefit.

ARNOLD KNAPP.

Les arachnoïdites opto-chiasmaticques. By J. Bollack, M. David and P. Puech. Pp. 295, with 76 illustrations. Paris: Masson et Cie, 1937.

This publication constitutes the ninth annual volume of the Société française d'ophtalmologie and maintains the high standards set by its predecessors. Lesions near the chiasm, particularly those around the point of emergence of the optic nerves, are considered. The discussion is based on reports of cases collected from the literature and from previously unpublished records from the neurosurgical service of Dr. Vincent at the Hôpital de la Pitié in Paris. Accordingly, the authors have been able to associate the knowledge of neurosurgeons with that of ophthalmologists and to correlate their findings.

The arrangement of the book is logical, the normal anatomy and histology being dealt with first. The symptoms are grouped under ocular and extraocular. The former comprise modifications of visual acuity, alterations in the visual field and disturbances in the fundi. The latter deal with those revealed by roentgenography and ventriculography.

No characteristic syndrome is produced by arachnoiditis in the region of the chiasma. Visual acuity may diminish slowly, after transient premonitory obscurations, or it may be lost suddenly, without warning. One or both eyes may be affected. Charting of the visual field may reveal almost any known defect. The disks may be normal, hyperemic, swollen or pale. Ocular motor signs are rare, but may include paralysis of the sixth or third nerves. Extraocular symptoms, if present, may include unlocalized headache, somnolence, vomiting or even convulsions. Roentgenograms and ventriculograms are normal.

In discussing diagnosis, the authors consider the inflammatory lesions separately, pointing out differences between the behavior of these lesions and of tumors in the region of the chiasma, chiefly meningiomas of the olfactory nerve and lesser wing of the sphenoid, hypophysial adenomas, craniopharyngiomas, gliomas and meningiomas

of the tuberculum sellae ossis sphenoidalis. The diagnosis is usually made by elimination and can be confirmed only by operation.

In determining the type of treatment, the authors point out the handicaps imposed on the physician by gaps in the knowledge concerning etiology. In the early stages, medical treatment is indicated, consisting chiefly of the use of iodides, salicylates and mercuric cyanide. When vision is threatened, surgical intervention is indicated. The operation of choice is transfrontal exploration and liberation of the adhesions around the origins of the optic nerve. The results are favorable in comparatively recent cases but unfavorable when optic atrophy has become far advanced. The authors stress the importance of operating at the proper time (*au bon moment*), after the conservative treatment has failed to produce results but before the lesions have become too well defined.

The monograph contains all that is known of lesions about the chiasm and should be studied carefully, not only by ophthalmologists but by neurosurgeons as well.

G. M. BRUCE.

Chemistry of the Brain. By Irvine H. Page, M.D., Associate Member of the Rockefeller Institute for Medical Research, New York. Price, \$7.50. Pp. 444, with 52 tables. Springfield, Ill.: Charles C. Thomas, Publisher, 1937.

In this monograph an attempt is made to bring together the scattered results of innumerable workers in the field of the chemistry of the brain. The author's clinical and chemical experience has rendered him peculiarly fitted for writing a chemical treatise on this complex organ. Since the only other monograph of this kind is that of Thudichum, which was published in English in 1884 and in a revised edition in German in 1901, there is a distinct need for an orientation and a comprehensive summary in this neglected field. Because mental diseases are so common and are an extreme social and economic liability, it is surprising that the interest in the chemistry of the brain has not been more intense. More investigations have been made on cerebrospinal fluid than on brain, the basic tissue of neurology.

The monograph is divided into chapters covering the nature of the various constituents and processes occurring in the normal and in the diseased brain. The chemistry of special senses, nerves and cerebrospinal fluid is intentionally omitted. Sterols, phosphatides, cerebrosides, fats, carbohydrates, nitrogenous substances, gases, vitamins, minerals and enzymes and physical chemistry are discussed. A special chapter on oxidations in the brain, written by J. H. Quastel, is included.

There are certain points in the discussions which are of interest to the ophthalmologist. Since the retina may be considered as an anatomic extension of the brain, one may easily acquire, on perusal of this treatise a comparable idea of the great gaps of knowledge which are missing in retinal chemistry. Of particular interest to the oculist are the short sections on the relation of intoxication, vitamin deficiency, xanthomatosis, amaurotic family idiocy, hepatolenticular degeneration, Niemann-Pick's disease and the Hand-Schüller-Christian syndrome to the chemistry of the brain.

From a narrow point of view, a criticism may be made of the use of the many technical and detailed points in chemistry, which frequently appear to have no bearing on the chemistry of the brain. It is almost impossible, however, to discuss the chemistry restricted to a special tissue without involving the field of organic and biologic chemistry, as the subject is interwoven with allied sciences. A brief treatise usually lacks this method of approach and requires much collateral reading for mental digestion. It is fortunate that the author has this broad outlook.

The ophthalmologist who is especially intrigued with ocular chemistry may read this monograph with difficulty, but with profit.

ARLINGTON C. KRAUSE.

Twenty-Fourth Annual Report of the Ophthalmic Hospitals Section for 1936. Ministry of Public Health, Egypt. Price, 10 piasters. Pp. 44, with many illustrations. Cairo: Government Press, 1937.

This report was evidently compiled in time for the Fifteenth International Ophthalmologic Congress in Cairo, because it contains many illustrations of the various ophthalmic hospitals in Egypt—so-called permanent and traveling ophthalmic units.

During 1936, 4 additional ophthalmic branches were opened in the hospitals in Egypt, 1,133,599 new patients were treated and 344,661 operations were performed. The percentage of blindness among the patients was nearly 6, about the same as in previous years. Eighty per cent of the cases of blindness were due to acute ophthalmia and its sequelae; glaucoma was responsible for blindness in nearly 6,000 cases, and the gonococcus remained the predominating factor in the production of acute conjunctivitis.

Postgraduate instruction was continued during the year. The report includes the records of a large number of interesting cases.

A report of the Ophthalmological Society of Egypt is given, followed by a description of the activities of the local organizing committee for the Fifteenth International Ophthalmologic Congress.

Of the operations performed, about 2,000 were for cataract and over 100,000 for trichiasis. The other operations, 27,000 in number, consisted of 1,182 trephinings, 4,000 iridectomies for adherent glaucoma, 7,774 excisions of the lacrimal sac, 31 operations for ptosis and about 9,000 enucleations, while tenotomy and advancement were done only 24 times. The number of operations for strabismus seems strikingly small, considering that there were nearly 50,000 cases of strabismus observed. Evidently a deviating eye is not regarded as a handicap.

One cannot but admire this wonderful amount of work, done probably under most trying conditions.

ARNOLD KNAPP

Directory of Ophthalmologic Societies *

INTERNATIONAL

INTERNATIONAL ASSOCIATION FOR PREVENTION OF BLINDNESS

Honorary President: Prof. F. de Lapersonne, 217 Fauborg St. Honoré, Paris.
President: Dr. P. Baillart, 66 Boulevard Saint-Michel, Paris, 6^e.
Secretary-General: Prof. M. Van Duyse, Université de Gand, Gand, Prov. Ostflandern, Belgium.
All correspondence should be addressed to the President, Dr. P. Baillart.

INTERNATIONAL OPHTHALMOLOGIC CONGRESS

Secretary: Dr. E. Marx, Costzeedijk 316, Rotterdam, Netherlands.

INTERNATIONAL ORGANIZATION AGAINST TRACHOMA

President: Dr. A. F. MacCallan, 33 Welbeck St., London, W., England.

FOREIGN

BRITISH MEDICAL ASSOCIATION, SECTION ON OPHTHALMOLOGY

President: Dr. Stewart Duke-Elder, 59 Harley St., London, W. 1.
Secretary: Dr. Thomasina Belt, 13 Mitchell Ave., Jesmond, Newcastle-on-Tyne.
Place: Plymouth. Time: July 20-22, 1938.

CHINESE OPHTHALMOLOGICAL SOCIETY OF PEIPING

President: Dr. H. T. Pi, Peiping Union Medical College, Peiping.
Secretary: Dr. C. K. Lin, 180 Hsi-Lo-yen, Chienmeng, Peiping.
Place: Peiping Union Medical College, Peiping. Time: Last Friday of each month.

GERMAN OPHTHALMOLOGICAL SOCIETY

President: Prof. W. Lohlein, Berlin.
Secretary: Prof. E. Engelking, Heidelberg.
Place: Heidelberg. Time: July 4-6, 1938.

MIDLAND OPHTHALMOLOGICAL SOCIETY

President: Dr. T. E. Ashdown Carr, 34 Charnwood St., Derby, England.
Secretary: T. Harrison Butler, 81 Edmund St., Birmingham, England.
Place: Birmingham and Midland Eye Hospital.

OPHTHALMOLOGICAL SOCIETY OF EGYPT

President: Prof. Dr. Sayed Abdel Hamid Soliman Pasha, Faculty of Medicine, Cairo.
Secretary: Dr. Abdel Fattah El Tobgy, 3 Midan Soliman Pasha, Cairo.

OPHTHALMOLOGICAL SOCIETY OF THE UNITED KINGDOM

President: Mr. Gordon M. Holmes, 9 Wimpole St., London, W. 1.
Secretary: Mr. J. D. M. Cardell, 27 Weymouth St., London, W. 1.

OPHTHALMOLOGY SOCIETY OF BOMBAY

President: Dr. D. D. Sathaye, 127 Girgaum Road, Bombay 4.
Secretary: Dr. H. D. Dastur, Dadar, Bombay 14.
Place: H. B. A. Free Ophthalmic Hospital, Parel, Bombay 12. Time: First Friday of every month.

* Secretaries of societies are requested to furnish the information necessary to make this list complete and to keep it up to date.

OXFORD OPHTHALMOLOGICAL CONGRESS

Master: Dr. C. G. Russ Wood, Hill House, Abberbury Rd., Iffley, Oxford, England.

Hon. Secretary-Treasurer: Dr. F. A. Anderson, 12 St. John's Hill, Shrewsbury, England.

Time: July 7-9, 1938.

PALESTINE OPHTHALMOLOGICAL SOCIETY

President: Dr. Arie Feigenbaum, Abyssinian Str. 15, Jerusalem.

Secretary: Dr. E. Sinai, Tel-Aviv.

POLISH OPHTHALMOLOGICAL SOCIETY

President: Dr. W. Kapuściński, 2 Waly Batorego, Poznań.

Secretary: Dr. J. Sobański, Lindley'a 4, Warsaw.

Place: Lindley'a 4, Warsaw.

ROYAL SOCIETY OF MEDICINE, SECTION OF OPHTHALMOLOGY

President: Dr. Ransom Pickard, 31 E. Southernhay, Exeter, England.

Secretary: Dr. A. Rugg-Gunn, 35 Harley St., London, W. 1.

SOCIÉTÉ FRANÇAISE D'OPHTALMOLOGIE

Secretary: Dr. René Onfray, 6 avenue de la Motte Picquet, Paris, 7è.

SOCIETY OF SWEDISH OPHTHALMOLOGISTS

President: Prof. K. G. Ploman, Stockholm, Sweden.

Secretary: Dr. K. O. Granström, Södermalmstorg 4 III tr., Stockholm, Sö., Sweden.

TEL-AVIV OPHTHALMOLOGICAL SOCIETY

President: Dr. D. Arie Friedman, 96 Allenby Str., Tel-Aviv.

Secretary: Dr. Sadger Max, 9 Bialik Str., Tel-Aviv.

TSINAN OPHTHALMOLOGICAL SOCIETY

Chairman: Dr. Eugene Chan, Cheeloo University School of Medicine, Tsinan, Shantung.

Place: Cheeloo University School of Medicine. Time: Last Thursday of alternate months.

NATIONAL

AMERICAN MEDICAL ASSOCIATION, SCIENTIFIC ASSEMBLY, SECTION ON OPHTHALMOLOGY

Chairman: Dr. Parker Heath, 1553 Woodward Ave., Detroit.

Secretary: Dr. Derrick T. Vail Jr., 441 Vine St., Cincinnati.

Place: San Francisco. Time: June 13-17, 1938.

AMERICAN ACADEMY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY, SECTION ON OPHTHALMOLOGY

President: Dr. Harry S. Gradle, 58 E. Washington St., Chicago.

Executive Secretary-Treasurer: Dr. William P. Wherry, 1500 Medical Arts Bldg., Omaha.

Place: Washington, D. C. Time: Oct. 9-14, 1938.

AMERICAN OPHTHALMOLOGICAL SOCIETY

President: Dr. Frederick H. Verhoeff, 243 Charles St., Boston.

Secretary-Treasurer: Dr. Eugene M. Blake, 303 Whitney Ave., New Haven, Conn.

Place: San Francisco. Time: June 9-11, 1938.

CANADIAN OPHTHALMOLOGICAL SOCIETY

President: Dr. W. Gordon M. Byers, 1458 Mountain St., Montreal.

Secretary-Treasurer: Dr. Alexander E. MacDonald, 421 Medical Arts Bldg., Toronto.

NATIONAL SOCIETY FOR THE PREVENTION OF BLINDNESS

President: Mr. William Fellowes Morgan, 50 W. 50th St., New York.
Secretary: Miss Regina E. Schneider, 50 W. 50th St., New York.

SECTIONAL

CENTRAL WISCONSIN SOCIETY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

President: Dr. L. C. Gardner, 11 N. Main St., Fond du Lac.
Secretary: Dr. G. L. McCormick, 626 S. Central Ave., Marshfield.
Place: Marshfield. Time: May 1938.

NEW ENGLAND OPHTHALMOLOGICAL SOCIETY

President: Dr. Edwin B. Goodall, 101 Bay State Rd., Boston.
Secretary-Treasurer: Dr. William P. Beetham, 5 Bay State Rd., Boston.
Place: Massachusetts Eye and Ear Infirmary, 243 Charles St., Boston. Time:
8 p. m., third Tuesday of each month from November to April, inclusive.

PACIFIC COAST OTO-OPHTHALMOLOGICAL SOCIETY

President: Dr. William D. Donohue, 1930 Wilshire Blvd., Los Angeles.
Secretary-Treasurer: Dr. C. Allen Dickey, 450 Sutter St., San Francisco.
Place: Victoria, B. C. Time: June 21-24, 1938.

PUGET SOUND ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. A. W. Howe, 740 St. Helens Ave., Tacoma, Wash.
Secretary-Treasurer: Dr. Purman Dorman, 1115 Terry Ave., Seattle.
Place: Seattle or Tacoma, Wash. Time: Third Tuesday of each month, except
June, July and August.

ROCK RIVER VALLEY EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. Frank W. Broderick, 501 Central Trust Bldg., Sterling, Ill.
Secretary-Treasurer: Dr. Thorsten E. Blomberg, 501-7th St., Rockford, Ill.
Place: Rockford, Ill., or Janesville or Beloit, Wis. Time: Third Tuesday of
each month.

SAGINAW VALLEY ACADEMY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

President: Dr. W. K. Slack, 308 Eddy Bldg., Saginaw, Mich.
Secretary-Treasurer: Dr. Andre Cortopassi, 703 Second National Bank Bldg.,
Saginaw, Mich.
Place: Saginaw or Bay City, Mich. Time: Second Tuesday of each month,
except July and August.

SIoux VALLEY EYE AND EAR ACADEMY

President: Dr. J. H. Judd, 107 S. 17th St., Omaha, Neb.
Secretary-Treasurer: Dr. J. C. Decker, 515 Frances Bldg., Sioux City, Iowa.

SOUTHERN MEDICAL ASSOCIATION, SECTION ON EYE, EAR, NOSE AND THROAT

Chairman: Dr. Grady E. Clay, Medical Arts Bldg., Atlanta, Ga.
Secretary: Dr. John R. Hume, 921 Canal St., New Orleans.

SOUTHWESTERN MICHIGAN TRIOLOGICAL SOCIETY

President: Dr. John Hunter McRae, 26 Sheldon Ave., S. E., Grand Rapids.
Secretary-Treasurer: Dr. Dewey R. Heetderks, 405 Medical Arts Bldg., Grand
Rapids.
Time: Third Thursday of alternate months.

WESTERN PENNSYLVANIA EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. C. M. Harris, Johnstown.
Secretary-Treasurer: Dr. C. Wearne Beals, Weber Bldg., DuBois.
Place: Johnstown. Time: May 19, 1938.

STATE

COLORADO OPHTHALMOLOGICAL SOCIETY

President: A presiding officer is selected for each meeting alternately until all members have served.

Secretary: Dr. John C. Long, 324 Metropolitan Bldg., Denver.

Place: Capitol Life Bldg., Denver. Time 7:30 p. m., third Saturday of the month, October to April, inclusive.

CONNECTICUT STATE MEDICAL SOCIETY, SECTION ON EYE, EAR,
NOSE AND THROAT

President: Dr. Charles T. Flynn, 41 Trumbull St., New Haven.

Secretary-Treasurer: Dr. Shirley H. Baron, 309 State St., New London.

Place: New London. Time: February 1938.

EYE, EAR, NOSE AND THROAT CLUB OF GEORGIA

President: Dr. John King, Thomasville.

Secretary-Treasurer: Dr. Mason Baird, 384 Peachtree St., Atlanta.

Place: Augusta. Time: May 1938.

INDIANA ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. C. W. Rutherford, 23 E. Ohio St., Indianapolis.

Secretary: Dr. Marlow W. Manion, 23 E. Ohio St., Indianapolis.

Place: Indianapolis. Time: First Wednesday in April.

IOWA ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. H. H. Lamb, American Bank Bldg., Davenport.

Secretary-Treasurer: Dr. B. M. Merkel, 604 Locust St., Des Moines.

Place: Davenport.

LOUISIANA-MISSISSIPPI OPHTHALMOLOGICAL AND OTOLARYNGOLOGICAL SOCIETY

President: Dr. C. A. McWilliams, G. and S. I. R. R. Bldg., Gulfport, Miss.

Secretary-Treasurer: Dr. Edley H. Jones, 1301 Washington St., Vicksburg, Miss.

Place: New Orleans. Time: Spring, 1938.

MICHIGAN STATE MEDICAL SOCIETY, SECTION OF OPHTHALMOLOGY
AND OTOLARYNGOLOGY

Chairman: Dr. F. N. Smith, Grand Rapids Clinic, Grand Rapids.

Secretary: Dr. Dewey R. Heetderks, 26 Sheldon Ave., S. E., Grand Rapids.

MINNESOTA ACADEMY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

President: Dr. Walter E. Camp, 1918 Medical Arts Bldg., Minneapolis.

Secretary-Treasurer: Dr. George E. McGeary, 920 Medical Arts Bldg., Minneapolis.

Time: Second Friday of each month from October to May.

MONTANA ACADEMY OF OTO-OPHTHALMOLOGY

President: Dr. Roy Grigg, Bozeman.

Secretary: Dr. A. W. Morse, 507 Phoenix Bldg., Butte.

NEW JERSEY STATE MEDICAL SOCIETY, SECTION ON OPHTHALMOLOGY,
OTOLOGY AND RHINOLARYNGOLOGY

Chairman: Dr. Oram Kline, 414 Cooper St., Camden.

Secretary: Dr. James S. Shipman, 542 Cooper St., Camden.

NEW YORK STATE MEDICAL SOCIETY, EYE, EAR, NOSE AND THROAT SECTION

Chairman: Dr. Marvin F. Jones, 121 E. 60th St., New York.

Secretary: Dr. Algernon B. Reese, 73 E. 71st St., New York.

Time: May 10, 1938.

NORTH CAROLINA EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. J. M. Lilly, 302 Old St., Fayetteville.

Secretary-Treasurer: Dr. Frank C. Smith, 106 W. 7th St., Charlotte.

Place: Charlotte. Time: October.

NORTH DAKOTA ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. H. Rosenberger, 221-5th St., Bismarck.

Secretary-Treasurer: Dr. F. L. Wicks, 514-6th St., Valley City.

Place: Bismarck. Time: May 1938.

OREGON ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. A. B. Dykman, Medical Dental Bldg., Portland.

Secretary-Treasurer: Dr. Andrew J. Browning, 418 Mayer Bldg., Portland.

Place: Good Samaritan Hospital, Portland. Time: Third Tuesday of each month.

RHODE ISLAND OPHTHALMOLOGICAL AND OTOLOGICAL SOCIETY

Acting President: Dr. N. Darrell Harvey, 112 Waterman St., Providence.

Secretary-Treasurer: Dr. Linley C. Happ, 124 Waterman St., Providence.

Place: Rhode Island Medical Society Library, Providence. Time: 8:30 p. m., second Thursday in October, December, February and April.

SOUTH CAROLINA SOCIETY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

President: Dr. George Truluck, Orangeburg.

Secretary: Dr. J. W. Jervey Jr., 101 Church St., Greenville.

TENNESSEE ACADEMY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

President: Dr. Kate Savage Zerfoss, 165-8th Ave., N., Nashville.

Secretary-Treasurer: Dr. W. D. Stinson, 805 Medical Arts Bldg., Memphis.

TEXAS OPHTHALMOLOGICAL AND OTO-LARYNGOLOGICAL SOCIETY

President: Dr. T. E. Fuller, 100 W. Board St., Texarkana, Texas.

Secretary: Dr. O. M. Marchman, 1719 Pacific Ave., Dallas.

UTAH OPHTHALMOLOGICAL SOCIETY

President: Dr. V. P. White, 143½ S. Main St., Salt Lake City.

Secretary-Treasurer: Dr. E. B. Fairbanks, Boston Bldg., Salt Lake City.

Time: Third Monday of each month.

VIRGINIA SOCIETY OF OTO-LARYNGOLOGY AND OPHTHALMOLOGY

President: Dr. M. H. Hood, 505 Washington St., Portsmouth.

Secretary-Treasurer: Dr. Charles T. St. Clair, 418 Bland St., Bluefield, W. Va.

WEST VIRGINIA STATE MEDICAL ASSOCIATION, EYE, EAR, NOSE
AND THROAT SECTION

President: Dr. George Traugh, 309 Cleveland Ave., Fairmont.

Secretary: Dr. Welch England, 621½ Market St., Parkersburg.

LOCAL

ACADEMY OF MEDICINE OF NORTHERN NEW JERSEY, SECTION ON
EYE, EAR, NOSE AND THROAT

President: Dr. James A. Fisher, 501 Grand Ave., Asbury Park.

Secretary: Dr. William F. McKim, 488 Sanford Ave., Newark.

Place: 91 Lincoln Park South, Newark. Time: 8:45 p. m., second Monday of each month, October to May.

AKRON ACADEMY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

President: Dr. L. E. Brown, Second National Bldg., Akron.
 Secretary-Treasurer: Dr. C. R. Anderson, 106 S. Main St., Akron.
 Time: First Monday in January, March, May and November.

ATLANTA EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. J. Mason Baird, Medical Arts Bldg., Atlanta, Ga.
 Secretary: Dr. Alton V. Hallum, 478 Peachtree St., Atlanta, Ga.
 Place: Academy of Medicine, 38 Prescott St. Time: Second Friday of each month from October to May.

BALTIMORE MEDICAL SOCIETY, SECTION ON OPHTHALMOLOGY

Chairman: Dr. Henry F. Graff, 513 N. Charles St., Baltimore.
 Secretary: Dr. Frank B. Walsh, Wilmer Institute, Johns Hopkins Hospital, Baltimore.
 Place: Medical and Chirurgical Faculty, 1211 Cathedral St. Time: 8:30 p. m., fourth Thursday of each month from October to May.

BROOKLYN OPHTHALMOLOGICAL SOCIETY

President: Dr. Walter V. Moore, 1 Nevins St., Brooklyn.
 Secretary-Treasurer: Dr. Mortimer A. Lasky, 1 Nevins St., Brooklyn.
 Place: Kings County Medical Society Bldg., 1313 Bedford Ave. Time: Third Thursday in February, April, May, October and December.

BUFFALO OPHTHALMOLOGIC CLUB

President: Dr. Ivan J. Koenig, 40 North St., Buffalo.
 Secretary-Treasurer: Dr. Meyer H. Riweh, 367 Linwood Ave., Buffalo.
 Time: Second Thursday of each month.

CHATTANOOGA SOCIETY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

President: Each member, in alphabetical order.
 Secretary: Dr. A. H. Benz, 706 Medical Arts Bldg., Chattanooga.
 Place: Mountain City Club. Time: Second Thursday of each month from September to May.

CHICAGO OPHTHALMOLOGICAL SOCIETY

President: Dr. Georgiana Dvorak-Theobald, 715 Lake St., Oak Park.
 Secretary-Treasurer: Dr. Earle B. Fowler, 55 E. Washington St., Chicago.
 Place: Medinah Michigan Avenue Club, 505 N. Michigan Ave. Time: Third Monday of each month from October to May.

CINCINNATI OPHTHALMIC CLUB

Chairman: Each member, in rotation.
 Secretary-Treasurer: Dr. E. R. Thomas, 819 Carew Tower, Cincinnati.
 Place: Holmes Memorial Library, Cincinnati General Hospital. Time: 8:15 p. m., third Monday of each month except June, July and August.

CLEVELAND ACADEMY OF MEDICINE, SECTION OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

Chairman: Dr. Webb Chamberlin, 7405 Detroit Ave., Cleveland.
 Secretary: Dr. Walter H. Rieger, Hanna Bldg., Cleveland.
 Place: Winton Hotel. Time: Fourth Friday of each month.

CLEVELAND OPHTHALMOLOGICAL CLUB

Chairman: Dr. Paul Moore, Republic Bldg., Cleveland.
 Secretary: Dr. G. Leslie Miller, 14805 Detroit Ave., Cleveland.
 Time: Second Tuesday in October, December, February and April.

COLLEGE OF PHYSICIANS, PHILADELPHIA, SECTION ON OPHTHALMOLOGY

Chairman: Dr. Charles R. Heed, 1205 Spruce St., Philadelphia.
 Clerk: Dr. Alexander G. Fewell, 1924 Pine St., Philadelphia.
 Time: Third Thursday of every month from October to April, inclusive.

COLUMBUS OPHTHALMOLOGICAL AND OTO-LARYNGOLOGICAL SOCIETY

Chairman: Dr. C. E. Silbernagle, 247 E. State St., Columbus, Ohio.
 Secretary-Treasurer: Dr. D. M. Johnson, 327 E. State St., Columbus, Ohio.
 Place: Deshler Wallick Hotel. Time: 6 p. m., first Monday of each month.

CORPUS CHRISTI EYE, EAR, NOSE AND THROAT SOCIETY

Chairman: Dr. Edgar G. Mathis, 416 Chaparral St., Corpus Christi, Texas.
 Secretary: Dr. E. King Gill, 416 Chaparral St., Corpus Christi, Texas.
 Time: Second Thursday of each month from October to May.

DALLAS ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. Lester H. Quinn, 4105 Live Oak, Dallas, Texas.
 Secretary: Dr. J. Dudley Singleton, 1719 Pacific Ave., Dallas, Texas.
 Place: Dallas Athletic Club. Time: 6:30 p. m., first Tuesday of each month from October to June. The November, January and March meetings are devoted to clinical work.

DES MOINES ACADEMY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

President: Dr. E. G. Linn, 604 Locust St., Des Moines, Iowa.
 Secretary-Treasurer: Dr. Grace Doane, 614 Bankers Trust Bldg., Des Moines, Iowa.
 Time: 7:45 p. m., third Monday of every month from September to May.

DETROIT OPHTHALMOLOGICAL CLUB

Chairman: Members rotate alphabetically.
 Secretary: Dr. William Fowler, 1424 Maccabee Bldg., Detroit.
 Time: 6:30 p. m., first Wednesday of each month.

EASTERN NEW YORK EYE, EAR, NOSE AND THROAT ASSOCIATION

President: Dr. J. D. Carroll, 102-3d St., Troy, N. Y.
 Secretary-Treasurer: Dr. Joseph L. Holohan, 330 State St., Albany.
 Time: Third Wednesday in October, November, March, April, May and June.

FORT WORTH EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. Van D. Rathgeber, 1012 Medical Arts Bldg., Fort Worth, Texas.
 Secretary-Treasurer: Dr. Charles R. Lees, 306 W. Broadway, Fort Worth, Texas.
 Place: Medical Hall, Medical Arts Bldg. Time: 7:30 p. m., first Friday of each month except July and August.

GRAND RAPIDS EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. Dewey R. Heetderks, 405 Medical Arts Bldg., Grand Rapids, Mich.
 Secretary-Treasurer: Dr. Robert G. Laird, 116 E. Fulton St., Grand Rapids, Mich.
 Place: Various local hospitals. Time: Third Thursday of alternating months, September to May.

HOUSTON ACADEMY OF MEDICINE, EYE, EAR, NOSE AND THROAT SECTION

President: Dr. L. Allen, 1215 Walker Ave., Houston, Texas.
 Secretary: Dr. George C. Farrish, 1625 Main St., Houston, Texas.
 Place: Medical Arts Bldg., Harris County Medical Society Rooms. Time: 8 p. m., second Thursday of each month from September to June.

INDIANAPOLIS OPHTHALMOLOGICAL AND OTOLARYNGOLOGICAL SOCIETY

President: Dr. C. P. Clark, 24 E. Ohio St., Indianapolis.

Secretary: Dr. Kenneth L. Craft, 23 E. Ohio St., Indianapolis.

Place: University Club. Time: 6:30 p. m., second Thursday of each month from October to May.

KANSAS CITY SOCIETY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. O. S. Gilliland, 1103 Grand Ave., Kansas City, Mo.

Secretary: Dr. John S. Knight, 1103 Grand Ave., Kansas City, Mo.

Time: Third Thursday of each month from September to May. The November, January and March meetings are devoted to clinical work.

LONG BEACH EYE, EAR, NOSE AND THROAT SOCIETY

Chairman: Dr. F. C. Hertzog, 117 E. 8th St., Long Beach, Calif.

Secretary-Treasurer: Dr. Ben K. Parks, 619 Professional Bldg., Long Beach, Calif.

Place: Professional Bldg. Time: Last Wednesday of each month from October to May.

LOS ANGELES SOCIETY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. Clifford B. Walker, 427 W. 5th St., Los Angeles.

Secretary-Treasurer: Dr. John P. Lordan, 2007 Wilshire Blvd., Los Angeles.

Place: Los Angeles County Medical Association Bldg., 1925 Wilshire Blvd. Time: 6:30 p. m., fourth Monday of each month from September to May, inclusive.

LOUISVILLE EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. J. S. Bumgardner, Heyburn Bldg., Louisville, Ky.

Secretary-Treasurer: Dr. Max Bornstein, Heyburn Bldg., Louisville, Ky.

Place: Brown Hotel. Time: 6:30 p. m., second Thursday of each month from September to May, inclusive.

MEDICAL SOCIETY OF THE DISTRICT OF COLUMBIA, SECTION OF
OPHTHALMOLOGY AND OTOLARYNGOLOGY

Chairman: Dr. Earle Breeding, 1801 I St., N. W., Washington.

Secretary: Dr. Elmer Shepherd, 1606-20th St., N. W., Washington.

Place: 1718 M St., N. W. Time: 8 p. m., third Friday of each month from October to April, inclusive.

MEMPHIS SOCIETY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

Chairman: Each member, in alphabetical order.

Secretary: Dr. Sam H. Sonders, Medical Arts Bldg., Memphis, Tenn.

Place: Eye Clinic of Memphis Eye, Ear, Nose and Throat Hospital. Time: 8 p. m., second Tuesday of each month.

MILWAUKEE OTO-OPHTHALMIC SOCIETY

President: Dr. John E. Mulsow, 231 W. Wisconsin Ave., Milwaukee.

Secretary-Treasurer: Dr. John B. Hitz, 411 E. Mason St., Milwaukee.

Place: University Club. Time: 6:30 p. m., second Tuesday of each month.

MINNEAPOLIS OPHTHALMOLOGICAL SOCIETY

Chairman: Each member, in alphabetical order.

Secretary: Dr. M. C. Pfunder, 645 Medical Arts Bldg., Minneapolis.

Place: Hennepin County Medical Society rooms. Time: 6:30 p. m., fourth Monday of each month, October to May, inclusive.

MONTGOMERY COUNTY MEDICAL SOCIETY

Chairman: Dr. A. G. Farmer, 1040 Fidelity Bldg., Dayton, Ohio.

Secretary-Treasurer: Dr. Rome M. Webster, 663 Reibold Bldg., Dayton, Ohio.

Place: Van Cleve Hotel. Time: 6:30 p. m., bimonthly, first Tuesday from October to June, inclusive.

MONTREAL OPHTHALMOLOGICAL SOCIETY

President: Dr. Stuart Ramsay, 1496 Mountain St., Montreal, Canada.
 Secretary: Dr. J. Rosenbaum, 1396 St. Catherine St., W., Montreal, Canada.
 Time: Second Thursday of October, December, February and April.

NASHVILLE ACADEMY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

Chairman: Dr. Guy Maness, 119-7th Ave., Nashville, Tenn.
 Secretary-Treasurer: Dr. Andrew Hollabaugh, Doctors Bldg., Nashville, Tenn.
 Place: St. Thomas Hospital. Time: 8 p. m., third Monday of each month from October to May.

NEW ORLEANS OPHTHALMOLOGICAL AND OTOLARYNGOLOGICAL SOCIETY

President: Dr. R. H. Fisher, Chess and Checker Club, New Orleans.
 Secretary-Treasurer: Dr. H. F. Brewster, 837 Gravier St., New Orleans.
 Place: Eye, Ear, Nose and Throat Hospital. Time: Third Thursday of each month from October to June.

NEW YORK ACADEMY OF MEDICINE, SECTION OF OPHTHALMOLOGY

Chairman: Dr. James W. White, 15 Park Ave., New York.
 Secretary: Dr. Rudolf Aebli, 30 E. 40th St., New York.
 Time: 8:30 p. m., third Monday of every month from October to May, inclusive.

NEW YORK SOCIETY FOR CLINICAL OPHTHALMOLOGY

President: Dr. Mark J. Schoenberg, 1160 Park Ave., New York.
 Secretary: Dr. Jesse Stark, 45 Park Ave., New York.
 Place: Squibb Hall, 745-5th Ave. Time: 7 p. m., first Monday of each month from October to May, inclusive.

OMAHA AND COUNCIL BLUFFS OPHTHALMOLOGICAL AND
 OTO-LARYNGOLOGICAL SOCIETY

President: Dr. A. J. Young, 107 S. 17th St., Omaha.
 Secretary-Treasurer: Dr. Delbert K. Judd, 1020 Medical Arts Bldg., Omaha.
 Place: Omaha Club, 20th and Douglas Sts., Omaha. Time: 6 p. m., dinner;
 7 p. m., program; third Wednesday of each month from October to May.

OPHTHALMOLOGICAL SOCIETY OF THE UNIVERSITY OF PITTSBURGH

President: Dr. W. W. Blair, 121 University Pl., Pittsburgh.
 Secretary: Dr. George H. Shuman, 351-5th Ave., Pittsburgh.
 Time: Second Monday in November, January, March and May.

PASSAIC-BERGEN OPHTHALMOLOGICAL CLUB

President: Dr. John S. Van Winkle, 297 Broadway, Paterson, N. J.
 Secretary-Treasurer: Dr. T. A. Sanfacon, 340 Park Ave., Paterson, N. J.
 Place: Paterson Eye and Ear Infirmary. Time: 9 p. m., last Friday of every month, except June, July and August.

PHILADELPHIA COUNTY MEDICAL SOCIETY, EYE SECTION

Chairman: Dr. Sidney L. Olsho, 235 S. 15th St., Philadelphia.
 Secretary: Dr. Edmund B. Spaeth, 1930 Chestnut St., Philadelphia.
 Time: First Thursday of each month from October to May.

PITTSBURGH OPHTHALMOLOGICAL SOCIETY

President: Dr. Glendon E. Curry, Westinghouse Bldg., Pittsburgh.
 Secretary: Dr. George H. Shuman, 351-5th Ave., Pittsburgh.
 Place: Pittsburgh Academy of Medicine Bldg. Time: Fourth Monday of each month, except June, July, August and September.

RICHMOND OPHTHALMOLOGICAL AND OTO-LARYNGOLOGICAL SOCIETY

President: Dr. N. H. Turner, 200 E. Franklin St., Richmond, Va.
 Secretary: Dr. Richard W. Vaughan, Medical Arts Bldg., Richmond, Va.
 Place: Westmoreland Club. Time: 6 p. m., second Monday of each month from October to May.

ROCHESTER EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. R. E. Elliott, 78 S. Fitzhugh St., Rochester, N. Y.
 Secretary-Treasurer: Dr. Raphael Farber, 280 Monroe Ave., Rochester, N. Y.
 Place: Rochester Medical Association, 113 Prince St. Time: 8 p. m., third Monday of each month from October to May.

ST. LOUIS OPHTHALMIC SOCIETY

President: Dr. Lawrence T. Post, 508 N. Grand Blvd., St. Louis.
 Secretary: Dr. Leslie Charles Drews, 508 N. Grand Blvd., St. Louis.
 Place: Oscar Johnson Institute. Time: Clinical meeting 5:30 p. m., dinner and scientific meeting 6:30 p. m., fourth Friday of each month from October to April, inclusive, except December.

SAN ANTONIO OPHTHALMOLO-OTO-LARYNGOLOGICAL SOCIETY

President: Dr. Oscar H. Judkins, 414 Navarro St., San Antonio, Texas.
 Secretary-Treasurer: Dr. Wilfred E. Muldoon, 414 Navarro St., San Antonio, Texas.
 Place: Bexar County Medical Library. Time: 8 p. m., first Tuesday of each month from October to May.

SAN FRANCISCO COUNTY MEDICAL SOCIETY, SECTION ON EYE,
EAR, NOSE AND THROAT

Chairman: Dr. Russell Fletcher, 490 Post St., San Francisco.
 Secretary: Dr. Avery Morley Hicks, 490 Post St., San Francisco.
 Place: Society's Bldg., 2180 Washington St., San Francisco. Time: Fourth Tuesday of every month except May, June, July and December.

SHREVEPORT EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. J. A. Wilkinson, Medical Arts Bldg., Shreveport, La.
 Secretary-Treasurer: Dr. W. L. Atkins, 940 Margaret Pl., Shreveport, La.
 Place: Shreveport Charity Hospital. Time: 7:30 p. m., first Monday of every month except July, August and September.

SPOKANE ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. Raymond A. Lower, 407 Riverside Ave., Spokane, Wash.
 Secretary: Dr. Louis A. Parsell, Paulsen Medical and Dental Bldg., Spokane, Wash.
 Place: Paulsen Medical and Dental Library. Time: 8 p. m., fourth Tuesday of each month except June, July and August.

SYRACUSE EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. Gordon D. Hoople, 110 Medical Arts Bldg., Syracuse, N. Y.
 Secretary-Treasurer: Dr. I. Herbert Katz, 212 Medical Arts Bldg., Syracuse, N. Y.
 Place: University Club. Time: First Tuesday of each month except June, July and August.

TORONTO ACADEMY OF MEDICINE, SECTION OF OPHTHALMOLOGY

Chairman: A. Lloyd Morgan, Medical Arts Bldg., Toronto, Canada.
 Secretary: Dr. W. R. F. Luke, Medical Arts Bldg., Toronto, Canada.
 Place: Academy of Medicine, 13 Queen's Pk. Time: First Monday of each month, November to April.

WASHINGTON, D. C., OPHTHALMOLOGICAL SOCIETY

President: Dr. G. Victor Simpson, 1710 Rhode Island Ave., N. W., Washington, D. C.
 Secretary-Treasurer: Dr. Frank D. Costenbader, 1726 I St., Washington, D. C.
 Place: Episcopal Eye, Ear and Throat Hospital. Time: 8 p. m., first Monday in November, January, March and May.

PERSONAL EXPERIENCES WITH INTRACAPSULAR CATARACT EXTRACTIONS

FREDERICK ALLISON DAVIS, M.D.

MADISON, WIS.

The intracapsular method of cataract extraction is increasing in popularity both in this country and abroad, though it has by no means supplanted the extracapsular procedure. While some ophthalmologists still reject the operation because of convictions concerning the wisdom of removing the posterior capsular diaphragm and the anatomic disturbance of the vitreous body, many have hesitated because of fear of the operation. From my limited experience, the latter seems entirely unjustified. The impression has prevailed that the intracapsular method is too hazardous for any but surgeons of large experience, and many men have avoided the operation for this reason. No doubt prejudice against intracapsular extraction has been due to early unfortunate results reported in this country following the use of the original method introduced by Colonel Smith. With the more refined and gentle technic of forceps extraction, this should be dispelled.

In this paper are reported the results of 200 consecutive intracapsular cataract extractions performed by me and by the members of the staff of the Wisconsin General Hospital during a period of four years. In about two thirds of the cases the operation was performed by me personally, and in the remainder, by associates, assistants and resident staff members. Thus, in considerable number the first intracapsular operations performed by members of the resident staff are included. This point is stressed in order that the reader may properly evaluate the results.

The operations herein reported were performed by the combined forceps and expression technic, similar to the methods originally intro-

From the Department of Ophthalmology, University of Wisconsin Medical School.

Read at a meeting of the American Academy of Ophthalmology and Otolaryngology, Chicago, Oct. 13, 1937.

Readers interested in the discussions on this article are referred to the Transactions of the American Academy of Ophthalmology and Otolaryngology (42: 235, 1937).

duced by Stanculeanu, Knapp and Török and modified by Lancaster, Šafář, Elschnig and others. There is, however, a definite variation or modification of their procedures, to be described later. It is beyond the scope of this paper to enter on a detailed description of the evolution of the forceps expression method of intracapsular extraction. This has been adequately covered by Lancaster.¹

There was no rigid rule for the selection of patients for operation, though those with complications, such as a high degree of myopia, an increase in intraocular tension, fluid vitreous or posterior synechiae, were usually, though not invariably, subjected to extracapsular extraction.

PREPARATION FOR OPERATION

Complete physical examination and Wassermann tests were given practically all patients. All foci of chronic sepsis were removed when possible. This pertained especially to abscessed teeth, pyorrhea and similar conditions. In those cases in which the lacrimal sac showed secretion or in which there was a history of recurrent infection, extirpation was performed prior to operation.

Smears from the conjunctiva of the lids were invariably made, and operation was rarely performed unless they were negative for bacteria and pus cells.

About 18 per cent of the patients were operated on under avertin anesthesia, the technic of which has been discussed by me elsewhere.² Those patients operated on under local anesthesia received $1\frac{1}{2}$ grains (0.09 Gm.) of pentobarbital sodium by mouth one-half hour prior to operation. One drop of a 3 per cent solution of euphthalmine hydrochloride was instilled into the conjunctival sac one hour before operation. The eyebrow was shaved or clipped.

TECHNIC

Operation.—Preparation on the operating table consisted of the usual thorough cleansing of the skin about both eyes and the painting of the skin of the lids, brow and nose with a 3 per cent tincture of iodine. This was usually wiped off with 70 per cent alcohol. The conjunctival sac was thoroughly irrigated with boric acid solution, and the lids were cleansed with a solution of mercury bichloride in a concentration of 1:5,000. From 5 to 6 drops of a 4 per cent solution of cocaine hydrochloride was instilled into the cul-de-sac over a period of twenty-five minutes. One or 2 drops of epinephrine hydrochloride in a concentration of 1:1,000 was instilled just before operation. Akinesia was produced according to the method of Van Lint. A 2 per cent solution of procaine hydrochloride was generally used, an injection also being made into the orbicularis muscle at the internal canthus. One drop of a 1 per cent solution of cocaine was injected subconjunctivally at the limbus below. Retro-orbital injection of procaine hydrochloride through the skin along the floor of the orbit was used in about 25 cases, but this was reserved for use in special instances.

A speculum was invariably used throughout the operation, Skeel's modification of Weeks' speculum being preferred in most cases.

1. Lancaster, W. B.: The Cataract Operation, Surg., Gynec. & Obst. **52**:452 (Feb.) 1931.

2. Davis, F. A.: Tribromethanol (Tribromomethyl-Alcohol, Avertin) as an Anesthetic in Eye Surgery, Tr. Am. Ophth. Soc. **29**:47, 1931.

Fixation of the globe was made at the lower margin of the internal rectus muscle at its insertion, an ordinary fixation forceps with a catch being used. A bridle suture under the superior rectus muscle was used in about half of the cases. A Graefe incision of from 35 to 45 per cent of the corneal circumference was used, with the addition of a conjunctival flap. The size of the incision was adapted to the type of cataract to be delivered. The section followed the limbus as closely as possible, with a conjunctival flap of moderate size. Two silk sutures were inserted immediately after the section and drawn aside. Usually two or three more sutures, sometimes four, were added after the end of the operation. The sutures were of the straight through and through type, of fine braided silk (Deknatel N004 B 1 test) tied in three knots. Carrel arterial needles, size B 21, full curved, were used for the conjunctival suturing.

A small iridectomy was done in most cases. In cases in which a simple extraction was performed a buttonhole peripheral iridectomy was done before delivery of the lens.

Extraction of the Lens.—The capsule of the lens was grasped at the junction of the lower and the middle third. Elschmig's or Arruga's forceps was used in most of the first 100 cases and my forceps in the remainder.

After the capsule was grasped, the forceps was held as steady as possible, with no rocking movement. Counterpressure was applied at the limbus below with the edge of the ordinary cataract spoon. The pressure was directed backward toward the optic nerve and was gentle and in no way comparable to the force formerly exerted in the Smith operation. Slight motions sidewise with the spoon to either side of 6 o'clock were made directly backward until the zonule ruptured and the lower edge of the lens appeared to luxate forward, after which the pressure was upward and a little backward, the forceps being synchronously withdrawn as the lens advanced upward through the wound. The forceps was never deliberately pulled on, except as pressure was applied below, and it was then withdrawn as the lens advanced upward through the incision.³ The lens tumbled in most instances, though frequently it was delivered head on, depending on the nature and size of the nucleus. The forceps aided in bringing the lens through the wound and also in breaking the upper zonular fibers. Gradle⁴ spoke of his method of intracapsular delivery as 80 per cent push and 20 per cent pull. The procedure described here might be considered as 95 per cent push and 5 per cent pull. After delivery, the sutures were immediately tied and additional sutures inserted. The pillars of the iris were then replaced.

If the capsule ruptured coming through the wound and there was a question of some remaining, the capsule forceps was again introduced just inside the lips of the wound and any remaining capsule was withdrawn. If the capsule ruptured before the lens was delivered, an ordinary extracapsular procedure was carried out, after it was ascertained that a large portion of the capsule had been removed.

A 2 per cent solution of pilocarpine nitrate was instilled into the eye in all cases at the close of the operation, a 1 per cent solution of physostigmine salicylate being added if the simple extraction was used. An ointment containing mercury bichloride in a concentration of 1:5,000 was placed between the lids

3. This method of delivery of the lens was first demonstrated to me by Dr. William L. Benedict. I have been unable to find any published description of the exact technic employed, though it corresponds closely to that described by Lancaster in his discussion before this society in 1933.

4. Gradle, H.: Intracapsular Versus Extracapsular Extraction of Cataract, Tr. Sect. Ophth., A. M. A., 1933, p. 186.

and especially over the lacrimal puncta. Gauze patches treated with petrolatum were placed over the lids, and the eyes were lightly bandaged for four days.

Postoperative Treatment.—The first dressing was done on the fourth day in cases in which complete iridectomy had been performed and after forty-eight hours in cases in which simple extraction was done. The patients were kept in bed from four to five days, the use of a back rest being permitted after forty-eight hours. A soapsuds enema was given on the fourth day. Sutures were removed on the seventh day unless they spontaneously extruded. The eye which was not operated on was uncovered on the fourth day after operation, and the eye subjected to operation was dressed on alternate days until the time of discharge, which for private patients was usually the tenth or twelfth day. The average stay in the hospital for patients in the wards was fourteen days. A 1 per cent solution of atropine was used at the postoperative dressings if needed, but frequently only one or two instillations were required, since the reaction was usually slight after the intracapsular procedure.

Refraction was done on the patients in the wards at the end of two weeks for a record of the visual acuity, but glasses were not prescribed until six weeks later. The records show that a number of patients failed to return to the hospital for final refraction; so the vision recorded is that at the time of discharge. The records show that vision was usually improved at the end of six weeks.

STATISTICAL ANALYSIS OF TWO HUNDRED INTRACAPSULAR EXTRACTIONS

Age.—The ages of the patients are shown in table 1, the grouping being done in decades from 40 to 90. (The youngest patient operated on was 42, and the oldest, 87.)

Description of Cataracts.—The state of maturity of the cataracts in this series is shown in table 2. One hundred and twenty-five of the cataracts were classed as mature, 58 as immature and 17 as hypermature. I have found it profitable to study each lens carefully after removal by tearing off the capsule and examining the cortex and nucleus. In this way one increases one's ability to judge more exactly the nature of the cataract before operation and thereby to choose the proper procedure and estimate the size of the section for removal in a given case.

With regard to the primary cause of the cataracts, I am unable to offer any important evidence. Nineteen patients had diabetes in varying states, though only 6 of these showed diabetic retinitis and only 2 were considered to have diabetic cataracts. Two patients had a high degree of myopia. Such patients are usually operated on by the extracapsular procedure, but owing to the marked immaturity of the cataracts of these 2 patients the intracapsular method was employed. Five patients had chronic simple glaucoma, in 1 of whom the eye had been trephined ten years earlier, with complete control of the tension. In this patient's case, incidentally, the cataract was extracted with complete success, with the capsule intact and with no loss of vitreous. There was 1 patient with an allergic cataract. In 1 case a detachment of the retina had existed for probably eight years. A presumptive preoperative diag-

nosis of detachment or intraocular tumor was made, and an extensive detachment was observed on the operating table immediately after removal of the lens, discernible by oblique illumination. In several cases there was subluxation of hypermature cataracts, with vitreous in the anterior chamber; these will be referred to later. In 1 case there had been an old mild plastic iritis, with slight posterior synechia.

Method of Operation.—Iridectomy, either preliminary or at the time of extraction, was performed in most cases, as shown in table 3. Personally, unless there is some definite indication to the contrary, I prefer the combined extraction, but others in the ophthalmic service prefer preliminary iridectomy. There is no occasion to discuss the rela-

TABLE 1.—*Ages of Two Hundred Patients Subjected to Intracapsular Cataract Extraction*

Age	Number of Patients
40 to 50 years.....	10
50 to 60 years.....	34
60 to 70 years.....	65
70 to 80 years.....	82
80 to 90 years.....	9
	<hr/> 200
Sex	
Men.....	109
Women.....	91
	<hr/> 200

TABLE 2.—*Description of Cataracts*

Type of Cataract	Number
Mature.....	125
Sclerosed.....	58
Ordinary senile.....	67
Immature.....	58
Amber nucleus, clear cortex.....	21
Ordinary immature, including postsubcapsular.....	37
Hypermature.....	17
Shrunken.....	15
Fluid cortex.....	1
Rubbery capsule.....	1
	<hr/> 200

tive merits of this practice here, as this is too well known and various surgeons differ in their preference. The simple extraction gives the ideal postoperative result when successfully performed, but from the standpoint of safety and simplicity of extraction complete iridectomy has a definite advantage. The 10 patients on whom simple extraction was done were younger subjects, and the results were highly successful from an operative and a visual standpoint, though prolapse under the conjunctival flap necessitated excision in 1 case.

The cases in which intracapsular extraction was attempted but failed are not included in this group, as the operations fall in the class of

extracapsular extractions. Records have been accurately kept, however, of the course in these cases. We were successful in extracting 79 per cent of the cataracts in capsule.

Condition of Capsule on Delivery.—Rupture of the capsule in my hands has been most common in cases of completely sclerosed cataract, in which the lens is large, hard and brown and contains no subcapsular cortical material. The capsule appears thin and friable and does not move freely on the underlying cortex, as seen in many lenses, since none is present. Tumbling is difficult, owing to the fact the lens will not fold. Fortunately these cataracts are ideal for extracapsular delivery, owing to the absence of soft cortex, though I usually attempt to remove them in capsule. In cases of glistening, slightly intumescent cataract, especially when the capsule is under slight tension, the capsule ruptures easily when grasped with the forceps.

TABLE 3.—*Method of Operation*

Type of Operation	Number of Cases
Preliminary iridectomy	103
Combined extraction	87
Simple extraction with peripheral iridectomy.....	10
	<hr/> 200

TABLE 4.—*Condition of Capsule on Delivery*

Condition of Capsule	Number of Cases
Capsule intact	164 (+ cases), 82%
Lens + capsule (capsule broke coming through wound but was completely removed)	36 (+ — cases), 18%

The hypermature cataract dislocates most easily, though when it is of the morgagnian variety and swollen and distended, with a rubbery capsule, it is practically impossible to grasp it, even with Fuch's toothed forceps. I have removed some of these easily in capsule by external pressure only.

The immature cataract, with a clear cortex and amber nuclear haze, is ideal for extraction. The capsule moves freely on the underlying cortex, which one may demonstrate by rubbing the extracted lens between the thumb and the forefinger. The capsule therefore is easily grasped without rupturing, owing to this freedom of movement and to the presence of ample pultaceous subcapsular material. The loose capsule can be seen projecting up through the jaws of the forceps. This feature of the forceps which I designed was described at a meeting of the American Ophthalmological Society,⁵ where it was exhibited. The

5. Davis, F. A.: Capsule Forceps for Intracapsular Cataract Extraction, Tr. Am. Ophth. Soc. 34:239, 1936.

large area of capsule which can be grasped distributes the traction over a good portion of the equator of the lens.

The fully mature, homogeneous, grayish white cataract is usually easily delivered, the capsule holding well.

As a general rule, the operation is most successful on persons in the age group from 60 to 90 years, since the zonule appears weakened and breaks easily. One is surprised at times, however, by the ease of extraction of the soft, white, rapidly developing cataract which is seen in the age group from 40 to 50 years, if time is allowed for a full, deep chamber.

Prolapse of the Vitreous.—A record of cases in which vitreous was lost, with the last recorded vision, is shown in table 5. The vitreous appeared in the lips of the wound or was lost in varying amounts in

TABLE 5.—*Analysis of Cases on Basis of Loss of Vitreous*

Case No.	Amount of Vitreous Lost	Vision	Condition of Capsule
1	Small amount with delivery.....	20/15	Intact
2	Fluid vitreous; small amount flowed out during operation....	20/20	Intact
3	Weak zonule; very little loss; lens fell back on grasping; lifted out in capsule.....	20/15	Intact
4	Tiniest amount; shrunken lens (15 years' duration) lifted out with forceps in capsule.....	20/200	Intact
5	Very small amount after delivery; poor cooperation.....	20/20	Intact
6	Moderate amount; lens fell into vitreous; delivered with loop..	20/30	Intact
7	Tiniest bead; appeared after suturing wound on replacing pillar	20/30+	+ —
8	Moderate loss after delivery.....	20/30	Intact
9	Four to five drops after delivery.....	20/20	Intact
10	Tiny drop after delivery.....	20/30	Intact
11	One drop after delivery	20/40	Intact
12	Two drops after delivery.....	20/30	Intact

12 cases, or in 6 per cent of the total number in which operation was performed. This number is less than that in another series of 100 cases in which extracapsular extraction was performed by substantially the same group of operators (aside from changing house officers) during the same period. In the latter series there was a loss of vitreous in 9 per cent of the cases. While this is contrary to the usual experience, Gradle⁴ reported similar results in 200 cases in which operation was performed (intracapsular in 100 and extracapsular in 100) by him. His records show loss of vitreous in 3 per cent of the cases in which intracapsular extraction was performed and in 7 per cent of those in which extracapsular extraction was done, though there were but 80 intracapsular deliveries.

In table 5 it will be noted that loss of vitreous was followed by poor vision in but 2 cases, namely, cases 4 and 11. In case 4 the amount of vitreous lost was insignificant, and the lowered acuity of vision could not be attributed to this, though the exact cause was difficult to determine, since the retina was essentially normal. The cataract was of the

hypermature, shrunken type, of fifteen years' duration; the iris was tremulous, and the vitreous was degenerated though not fluid. The lens fell back slightly when the capsule forceps was applied. Delivery was easily accomplished by reintroduction of the forceps, and after the capsule was again grasped the lens was lifted out intact. No loop was used, nor was pressure exerted on the globe with the spoon. This method of delivery of a subluxated lens has not been sufficiently stressed. It is far superior to the older method of loop and spoon delivery, in which a considerable amount of vitreous may be lost.

In case 11 a drop of vitreous was lost. The healing was prompt, but according to the record vision was only 20/40 on the fourteenth day, when the patient was discharged. The patient never returned for final refraction.

If the zonule does not break readily with moderate pressure on the globe, we usually abandon the effort and remove the capsule with the Fuchs capsule forceps.

With the possible exception of some of the house officers' first operations, in which loss of vitreous was due to inexperience, vitreous seemed to appear without apparent cause and when least expected. My own experience has been similar in cases in which the extracapsular method was used. Vitreous may appear when there has been a minimum amount of trauma, occasionally after the section and at times on replacing a pillar, or when the patient suddenly moves the eye. It would seem that it must be related to the condition of the hyaloid and the consistency or condition of the vitreous itself. In other words, some patients seem predestined to this complication, while every surgeon is familiar with types of cases in which excessive manipulation and unusual trauma are not followed by prolapse. Unquestionably the thorough paralysis of the orbicularis muscle by the injection of procaine hydrochloride has reduced this hazard by the complete elimination of squeezing, and large losses of vitreous seem to have vanished. In my earlier cases avertin was used when it was suspected that the patient might be a "squeezer" or a "bad actor," but with increasing confidence in the operation and a more thorough akinesia I have found its use less important.

It is, of course, unnecessary to stress the importance of measuring intraocular tension with the tonometer in every case prior to operation. The intracapsular procedure is usually avoided if tension cannot be brought well within normal limits.

Prolapse of the Iris.—This complication has occurred in a limited number of cases in this series, as is shown in table 6.

As noted in the table (case 1), prolapse of one pillar occurred on the eleventh day. The patient had had an exceptionally quiet eye and

was dismissed on the tenth day. Too great activity bending over caused one pillar to prolapse through the wound, without loss of the anterior chamber. It was excised, with prompt recovery.

In case 2, in which simple extraction was performed, a prolapse, completely covered by the conjunctival flap, was found at the first dressing. The patient vomited several times during the first night after operation and during the next day, from no apparent cause, as the operation was performed under local anesthesia. Excision was followed by prompt recovery, with little reaction and excellent vision.

In case 3 prolapse of one pillar occurred when the patient bumped her eye.

In case 4 there was hemorrhage into the anterior chamber, and the wound was sprung, with incarceration of one pillar beneath the flap, excision being necessary.

In cases 5, 6, 7 and 8 one pillar caught in the wound, but no intervention was necessary, since the eyes were quiet.

TABLE 6.—*Analysis of Cases on Basis of Incarceration and Prolapse of the Iris*

Case No.	Condition of Iris
1	Prolapse of one pillar on eleventh day (overactivity at home)
2	Prolapse after simple extraction (postoperative vomiting)
3	Prolapse of one pillar (patient struck eye)
4	Prolapse of one pillar (hemorrhage in the anterior chamber; wound sprung)
5	Caught pillar; no prolapse
6	Caught pillar; no prolapse
7	Caught pillar; no prolapse
8	Caught pillar; no prolapse

Hemorrhage into Anterior Chamber.—Hemorrhage into the anterior chamber was observed at various dates during the postoperative period from the fourth to the fourteenth day. In some of the cases its occurrence was definitely associated with trauma, such as turning in bed with pressure on the eye, getting out of bed and falling to the floor and on straining from an enema, but there were a number of cases in which hemorrhage seemed to occur spontaneously without injury of any kind. Most of the hemorrhages were small and cleared up promptly, but several were of considerable amount, completely filling the anterior chamber and in 2 cases causing a bulging of the flap with external oozing. The relative frequency of this mishap is puzzling aside from those hemorrhages directly due to trauma. Wright, in his masterly series of lectures on cataract, appearing in the *American Journal of Ophthalmology*, stated in his third lecture⁶ that he has encountered this accident in over 10 per cent of his cases and that in some years it

6. Wright, R. E.: Lectures on Cataract: Posterior-Segment Complications in the Postoperative Period; Some Difficult Extractions, *Am. J. Ophth.* 20:376 (April) 1937.

has been as high as 20 per cent. No better description of the varied aspects of this complication can be found anywhere. Detailed analysis of our cases in respect to hemorrhage will be found in table 7.

In this table it is revealed that postoperative hemorrhages into the anterior chamber occurred in 12 cases, in 1 of which it invaded the vitreous, and that quiet hemorrhages into the vitreous occurred in 2 cases. These results are surprisingly similar to the average of 7.6 per cent reported by Vail⁷ in statistics gathered from various sources and presented in his thesis, "Hyphemia After Cataract Extraction. My experience also confirms this writer's conclusion that the source of the bleeding in most cases seems most likely from the wound rather than from the iris.

TABLE 7.—*Analysis of Cases on Basis of Postoperative Hemorrhage into the Anterior Chamber*

Case No.	Day	Description of Hemorrhage	Cause of Hemorrhage	Final Vision
1	9th	Into the anterior chamber	Unknown	20/15
2	5th	Into the anterior chamber	Unknown	20/15
3	6th	Into the anterior chamber	Unknown	20/20
4	6th	Very slight; into the anterior chamber	Unknown	20/20
5	6th	Into the anterior chamber	Patient rolled onto eye	20/15
6	6th	Into the anterior chamber	Patient tore off bandage; coughing uncontrollable (same for other eye, extracapsular extraction)	20/40
7	6th	Into the anterior chamber	Unknown	20/15
8	5th	Severe; into the vitreous and anterior chamber	Patient bumped eye; prolapsed iris excised	Hand movements
9	4th	Small; into the anterior chamber	Unknown	20/20
10	4th	Small; into the anterior chamber	Fluid vitreous; no loss	20/15
11	17th	Small; into the anterior chamber	Patient struck eye	20/20
12	6th	Into the anterior chamber; quiet hemorrhage into the vitreous	Unknown (similar hyphema in other eye 6 mo. later)	20/30
13	8th	Into the anterior chamber	Loss of vitreous at operation; blood remained 5 wk.	20/30
14	?	Quiet hemorrhage into the vitreous	Complicated cataract; fluid vitreous	20/30

In my experience postoperative hemorrhage occurred as frequently in cases in which the extracapsular method was used; so it does not appear to be due to the intracapsular procedure. Hemorrhage was not definitely associated with diabetes in this series of cases, though I have observed a number of such cases previously in which the extracapsular method was used in which hemorrhage seemed to be related to a diabetic condition.

This study reveals no definite cause for the bleeding aside from postoperative trauma. A poor section, too scleral, appears definitely to predispose to postoperative hemorrhage. None occurred after simple

7. Vail, D. T., Jr.: Hyphemia After Cataract Extraction, Tr. Am. Ophth. Soc. **31**:496, 1933.

extractions. Quiet hemorrhage into the vitreous occurred in 2 cases; the hemorrhages were discovered only at the end of two weeks, when refraction and ophthalmoscopic examination were undertaken. The hemorrhages cleared up satisfactorily, though vitreous streamers remained. In only 1 case (8) did hemorrhage result in a marked reduction in vision, and this was a postoperative hemorrhage into the anterior chamber and vitreous on the fifth day, due to trauma.

Visual Results.—The visual results are presented in table 8. It should be noted that most of the patients operated on come from distant parts of the state, so that in many instances the vision recorded was that determined after a brief refraction on the day of discharge, usually the fourteenth day. The final refraction for some of these patients was done by their local physicians, though an effort was made to have all return for a thorough refraction and glasses at the end of from six weeks to two months.

TABLE 8.—*Record of Visual Results*

Vision	No. of Cases	Percentage
20/15.....	82	83% (20/30 or better)
20/20.....	54	
20/30.....	30	17% (20/40 or less)
20/40.....	8	
20/50.....	7	
20/70.....	5	
20/100.....	5	
20/200.....	6	
Hand movements.....	2	
Unknown.....	1	

As shown in table 8, 83 per cent of the patients obtained vision of 20/30 or better, while 17 per cent obtained vision of 20/40 or less. Vision of 20/30 or better was obtained in 71 per cent of the series of 100 cases in which extracapsular extraction was done.

In table 9 will be found an analysis of the cases in which intracapsular extraction resulted in vision of 20/40 or less. Eight of the 34 patients failed to return for final refraction, and the visual results in these cases are those obtained on the day of discharge, usually the fourteenth day.

Lowered visual acuity from loss of vitreous could not have been a contributing factor in but 2 cases in this group, and in 1 of these the visual record of 20/40 was that on the date of discharge—the fourteenth day. One patient with vision of 20/200 had a hypermature, shrunken cataract, of fifteen years' duration, with vitreous in the anterior chamber. The retina appeared normal, and the loss of vitreous was slight. Vision, however, could not be improved.

Aside from these cases and 1 in which hemorrhage occurred into the anterior chamber and vitreous, lowered visual acuity was chiefly due

to preexisting disease, such as a high degree of myopia, chronic glaucoma, diabetic retinitis, retinitis pigmentosa and macular degeneration. In 1 case both eyes were operated on, with perfect postoperative results, but vision of only 20/200 was obtained. The eyes appeared normal. The patient spoke no English and was of extremely low mentality.

Miscellaneous Data.—A few other features deserve comment.

In 1 patient aged 82 scarlet fever and otitis media developed on the sixth day after operation, with no interruption or complication in the

TABLE 9.—*Analysis of Cases in Which Vision of Less Than 20/30 Was Obtained*

Degree of Vision	Contributing Factors	No. of Patients
Vision 20/40	Patient did not return for refraction (vision on discharge).....	3
	Myopia	1
	Chronic glaucoma, preoperative.....	1
	Hyphemia (patient tore off bandages).....	1
	Hypermature cataract	1
	Cause unknown	1
Vision 20/50	Diabetic retinitis	3
	Chronic glaucoma; subluxated lens.....	1
	Macular degeneration	1
	Patient did not return for refraction (vision on 14th day).....	2
Vision 20/70	Retinal hemorrhages; hypertensive retinitis.....	1
	Hypermature cataract (15 years' duration); squint.....	1
	Macular degeneration	1
	Patient did not return for refraction (vision on 14th day).....	2
Vision 20/100	Corneal dystrophy	1
	Hypermature cataract (15 years' duration).....	1
	Diabetic retinitis	1
	High degree of myopia (20 D.); squint; vitreous change.....	1
	Patient did not return for refraction (vision on 14th day).....	1
Vision 20/200	Vitreous into anterior chamber; slight loss; complicated cataract (15 years' duration).....	1
	Diabetic retinitis	2
	Retinal detachment (8 years preoperatively; observed on operating table)	1
	Unknown (perfect intracapsular operation; normal fundi).....	2
Vision less than 20/200	Retinitis pigmentosa	1
	Hemorrhages into vitreous and anterior chamber 5th postoperative day	1
Vision unknown	Death from pneumonia (7th postoperative day).....	1

healing process, and vision of 20/20 was obtained. One other patient had mild otitis media. Six patients were disoriented, and 2 might be classed as having postoperative mania. All became rational promptly on removal of the patch from the eye which was not operated on and on getting out of bed. Several patients had delayed restoration of the anterior chamber, some as late as the ninth day. Watchful waiting, rest in bed and the use of a 2 per cent solution of pilocarpine nitrate daily was the only treatment employed, and finally the wound healed

in all cases without further complication. Late bulging of the wound under the flap occurred in a few cases, but there was never actual prolapse of vitreous. External oozing occurred in 2 of the cases with hyphemia. True iritis was observed in but 3 cases, and in none of them was it severe. In view of the statements of Knapp⁸ concerning this complication, I have searched our records for cases which might come in this category but can find only 3 which were so classified. The fact that fourteen days was the average length of hospitalization corroborates this in a way, since all patients were kept in the hospital until their eyes were quiet. In some cases the period of hospitalization was five weeks, but for the most part this was in cases in which hemorrhage had occurred. No doubt some degree of irritation of the iris was present in some of the cases, but frank iritis was exceptional.

Postoperative vomiting occurred infrequently—occasionally when no postoperative sedative was used. We scrupulously avoid the postoperative use of morphine, though it is used with scopolamine hydrobromide, $\frac{1}{200}$ grain (0.00032 Gm.), as a preliminary sedative in cases in which operation is done with avertin anesthesia. One-half grain (0.03 Gm.) of codeine sulfate and 5 grains (0.32 Gm.) of acetylsalicylic acid is the only postoperative sedative used, and this is avoided when possible.

Slit lamp study was carried out on all patients returning for refraction after six weeks. The anterior surface of the vitreous occasionally showed a bulging forward through the pupillary area, and rarely a rupture of the hyaloid was seen. At times holes were seen in the hyaloid, and pigment dust from the iris or blood was occasionally observed. As a rule, the hyaloid appeared smooth and flat. Opacities of the vitreous and fine streamers were seen in a number of cases, though no statistical study has been made of these. This condition is seen in so many cases before operation that it would be difficult to obtain an accurate record.

The number of patients in whom hypertensive cardiovascular disease was recorded was large. This condition rarely appeared to interfere with a satisfactory postoperative result.

Records of astigmatism conform so closely to the many observations recorded by others that no especial comment regarding this seems indicated.

In this series it will be noted there was not a single postoperative intraocular infection and no expulsive subchoroidal hemorrhage. Likewise, to date there has been no postoperative detachment of the retina.

8. Knapp, A.: Complications of the Forceps Intracapsular Cataract Operation, *Tr. Am. Ophth. Soc.* 34:162, 1936.

Choroidal detachment has been observed in only 1 case, but patients are not examined with the ophthalmoscope until the fourteenth day, except in rare instances.

COMMENT

After the warnings of such an outstanding authority as Wright,⁶ one hesitates to make any dogmatic statements concerning an operation when the series reported is not large. When one has employed the extracapsular operation exclusively for nineteen years, however, and then adds the intracapsular procedure for a period of four years, it is difficult to refrain from making comparison.

One of the greatest advantages of the intracapsular operation is the freedom it permits in operating on the immature cataract. Long waiting in semiblindness can be avoided in most cases. The cataract with light nuclear sclerosis and a clear peripheral cortex is ideal for the intracapsular procedure, and the operation can be undertaken as soon as the anterior chamber is of sufficient depth to permit a satisfactory section. The actual technic of the intracapsular procedure is simpler than that of the extracapsular procedure, if one uses forceps for removal of the anterior capsule in the latter operation, since various manipulations incident to the removal of retained cortex, such as massage of the cornea and irrigation of the anterior chamber, are completely eliminated. Careless irrigation with improper solutions has not infrequently resulted in marked postoperative irritation and at times permanent clouding of the cornea.

Naturally one must practice the technic of intracapsular removal a sufficient number of times to become thoroughly familiar with the operation. Coordination between pressure and light traction must be developed, and fear of sudden loss of vitreous must be overcome.

Fewer instruments are introduced into the anterior chamber, and the incidence of infection should be lower. Usually the stay in the hospital has been definitely shortened. Postoperative complications have been reduced in this series as compared with the cases in which extracapsular extraction was performed. The patients on the whole have been much happier owing to the freedom from postoperative irritation and the shorter period of hospitalization. No discissions for after-cataract are required, with their attendant embarrassment.

I believe that in the average case in which there are no complications the intracapsular operation, with some form of forceps extraction, should be the operation of choice. The optimum achievement in cataract extraction is obtained by a successful intracapsular procedure, with the preservation of a round pupil. The feature of safety, however, must always be kept in mind, and unquestionably some form of complete iridectomy adds to this, as stressed by Knapp and others. I believe that iridectomy should always be used for elderly persons, who poten-

tially are not cooperative and for whom a cosmetic result is not so essential. I prefer the simple extraction with peripheral buttonhole iridectomy for younger subjects. With a combined or preliminary iridectomy, as one prefers, the intracapsular operation appears as safe as the extracapsular procedure when there are no complications. If one considers the possible postoperative complications of the capsulotomy operation, the intracapsular procedure, in my opinion, is the safer.

Peters,⁹ in discussing Knapp's¹⁰ paper on his third series of 100 intracapsular extractions, stated that "if we eliminate the question of surgical skill and compare the results of the intra- and extracapsular methods there can be no reason for difference of opinion as to the much greater value of the intracapsular extraction."

Knapp¹⁰ pointed out that incarceration of the iris, opacities of the vitreous after removal of the cataract and glaucoma are all reduced to a minimum, while recovery is more rapid.

Török¹¹ in 1916, discussing his method of forceps extraction, stated that it is simple and easy for any one who is experienced with the ordinary Graefe extraction and, further, that the danger of loss of vitreous is even less, because pressure is less when traction is used.

Contrary to the usual teaching and belief with regard to the greater hazard of loss of vitreous with the intracapsular operation, I have grown less apprehensive about this phase of the procedure, as the number of my operations has increased, and, barring the exceptional case, it seems to me this complication should be no more frequently incurred than with the extracapsular method.

The outstanding features of the uncomplicated intracapsular extraction are the simplicity of the operative procedure, the slight postoperative reaction in most cases, the shortened period of postoperative healing and the rapid restoration of excellent vision.

Every ophthalmologist who removes any number of cataracts should be familiar with some form of intracapsular extraction. It may never completely replace the capsulotomy procedure, but certain types of cataract are best suited to the intracapsular method, and those who do not practice both methods will find themselves handicapped in the management of many of their patients.

9. Peters, in discussion on Knapp.¹⁰

10. Knapp, A.: Extraction of Cataract: Report of a Third Hundred Successive Extractions in the Capsule After Preliminary Subluxation with the Capsule Forceps, *Arch. Ophth.* 5:575 (April) 1931.

11. Török, E.: Extraction of Cataracts, *Ann. Ophth.* 25:712 (Oct.) 1916.

PRACTICE OF DARK ADAPTATION

A REVIEW

JACOB B. FELDMAN, M.D.

PHILADELPHIA

The purpose of this paper is to review the subject of dark adaptation and the technic for its study. A brief sketch of the common instruments used to record dark adaptation is given, with particular reference to the method by which the quality of the light is retained throughout its entire varying range of intensity. The quantitative instrument I now use in my studies is described.

Dark adaptation, as the term implies, is the ability which the eye has to adapt itself to darkness. For example, if one enters a darkened cinema theater on a sunny day, it is impossible at first to see any seats, but after a specified number of minutes objects are somewhat clearer. As time goes on, improvement in vision is noted, until the sight becomes as distinct as if the theater were illuminated. This physiologic function of the normal human being is one of dark adaptation. It takes a definite time for the eyes to become adapted to dark. Lack of perfection of this visibility in darkness or slowness of the eyes to gain clear vision constitutes pathologic dark adaptation, or dysadaptation.¹

PHYSIOLOGY OF ADAPTATION

The eye is capable of two types of vision: (1) form and color sense, for which good light is necessary, and (2) light sense, which is detected in subdued light or twilight. Form and color sense develops at about the sixth month of life. Light sense, however, is possibly fully developed soon after birth.

Believers in the von Kries² theory give credit to the cones of the retina for daylight vision (form and color sense). According to this theory, the rods, aided by the visual purple, are responsible for vision in the dark. The rods are more responsive to rays of the shorter wavelengths.

1. Dysadaptation is the name given to a pathologic or abnormally high light threshold reading by C. Edmund and S. Clemmesen (On Deficiency of A Vitamin and Visual Dysadaptation, Copenhagen, Levin & Munksgaard, 1936).

2. Only the von Kries theory is discussed here because I feel that this theory more adequately explains dark adaptation than any of the others. The various theories and their evaluation can be found in standard works on physiology.

Opponents of the duplicity theory of von Kries refute the dual action of rods and cones. They say that there is equality in sensitivity between the rods and the cones after prolonged dark adaptation. They are of the opinion that photopic and scotopic vision is a function of the cones which utilizes visual purple.

Believers in the von Kries theory, however, to prove their contention, note that nocturnal, or night-prowling, animals, such as moles, hedgehogs, mice, rats, night apes, owls and geckos, possess an abundance of rods, while animals which forage for food and carry on during daylight, such as the chameleon, birds, lizards and some reptiles, have an excess of cones in the retina.

Regardless of one's opinion relative to the von Kries theory, it is certain that the retina responds to two types of vision: (1) daylight, or photopic vision and (2) twilight, or scotopic vision. The latter is accomplished through the aid of the visual purple.

The changes in photopic vision are so rapid and so variable that they cannot be studied accurately.

Scotopic vision, on the other hand, is slower and can be investigated. This is accomplished by a study of the dark adaptation.

VITAMIN A

Studies have shown that there is a relation between visual purple and vitamin A and also between A avitaminosis and certain ocular diseases.

Wolff³ and Moore⁴ have found the liver to be the main source of vitamin A in the body.

Tansley⁵ has been able to show by photography the quantitative differences of regeneration of the visual purple in normal rats and in rats deficient in vitamin A.

Wald, according to Matthews,⁶ accounted for the presence of vitamin A in the retinal tissue by the combining of vitamin A in the blood with the visual purple in the eye.

Tassman⁷ has reviewed the subject of vitamin A as related to ophthalmology.

3. Wolff, L. K.: On the Quantity of Vitamin A Present in the Human Liver, *Lancet* 2:617, 1932.

4. Moore, T.: Vitamin A Reserves of the Human Liver in Health and Disease, *Lancet* 2:669, 1932.

5. Tansley, K.: The Regeneration of Visual Purple: Its Relation to Dark Adaptation and Night Blindness, *J. Physiol.* 71:442, 1931.

6. Matthews, A. P.: Principles of Biochemistry, Baltimore, William Wood & Company, 1936, p. 412.

7. Tassman, I. S.: Dietary Deficiency and Ocular Disease, *Arch. Ophth.* 8: 580 (Oct.) 1932.

CLINICAL IMPORTANCE OF STUDIES OF DARK ADAPTATION

Dark adaptation is the measure of the function of the receiving apparatus. Pathologic dark adaptation, therefore, indicates interference with the function of the deeper structures of the retina, viz., the rods, choroid and the visual purple. Study of the dark adaptation of a patient with cataract would therefore be of great aid in the preoperative prognosis. A study of dark adaptation shortly after an operation for glaucoma would indicate the restoration of function in the deeper retinal structures.

In the absence of an ocular pathologic process, dysadaptation of moderate degree would be strong presumptive evidence of a vitamin deficiency.

Avitaminosis A has been found to play an important role in such diseases as hepatic and intestinal disorders,⁸ renal calculi⁹ and certain diseases of the blood,¹⁰ or of the skin.¹¹

I have found some of these conditions to be accompanied with pathologic dark adaptation.¹²

Normal dark adaptation is important to safety in night travel in the air, on the sea and on the highway.¹³ Many accidents are due to more or less pronounced night blindness, of which the driver may be unaware.

CLASSIFICATION OF CLINICAL CASES FOR STUDY OF DARK ADAPTATION

I divide all of my patients who are to be subjected to a study of dark adaptation into three arbitrary groups. There is no sharp demarcation in the classification. Examination of a patient may reveal a pathologic condition which will permit classification under more than one group.

Group 1.—In the first group are placed patients in whom a physical or an anatomic disturbance is found. Included here are patients with—

8. Eusterman, G. B., and Wilbur, D. L.: Clinical Features of Vitamin A Deficiency, *J. A. M. A.* **98**:2054 (June 11) 1932.

9. Higgins, C. C.: The Experimental Production of Urinary Calculi, *Urol. & Cutan. Rev.* **38**:33, 1934.

10. Berglund, H.; Keefer, C. S., and Yang, C. S.: Deficiency Anemia in Chinese, Responding to Cod Liver Oil, *Proc. Soc. Exper. Biol. & Med.* **26**:418, 1929.

11. Frazier, C. N., and Hu, C. K.: Nature and Distribution According to Age of Cutaneous Manifestations of Vitamin A Deficiency, *Arch. Dermat. & Syph.* **33**:825 (May) 1936.

12. Feldman, J. B.: Further Studies on Dark Adaptation, *Arch. Ophth.* **17**:648 (April) 1937.

13. (a) Luckiesh, M., and Moss, F. K.: *The Science of Seeing*, New York, D. Van Nostrand Company, Inc., 1937, p. 22. (b) Jeghers, J.: Night Blindness Due to Vitamin A Deficiency: A Consideration of Its Importance in Traffic Problems, *New England J. Med.* **216**:51, 1937. (c) Feldman.¹²

out any visible retinal pathologic process or corneal opacity attributable to vitamin A deficiency. There is present, however, a physical disturbance in the size or function of the eye or a turbidity of the ocular media, which might be expected to cause pathologic dark adaptation. Included in this group are patients with conditions dependent on the factors of age and sex; patients with refractive errors of various sorts, and persons with color blindness, conical cornea, nystagmus, opacities of the cornea or of the vitreous, cataract, without other complications, dislocation of the lens and amblyopia ex anopsia.

Examination of a number of patients belonging to this group has shown normal dark adaptation.¹⁴

Group 2.—In the second group are placed patients in whom a physiologic disturbance is found. Here are included patients with a definite retinal pathologic process which is disturbing the physiologic function of the retina (rods). In this group are patients with choroiditis and retinal detachment; a great majority of patients with glaucoma and retinal arteriosclerosis; patients with congenital hemeralopia, such as retinitis pigmentosa and retinitis punctata albescens, and patients with idiopathic or acquired hemeralopia, such as the night blindness caused by overexposure to light, the type of night blindness seen in shell-shocked soldiers and a night blindness common to coal miners,¹⁵ in whom there may be overactivity of the visual purple.

A pathologic dark adaptation of varying degrees, which is usually higher than that in patients in group 3, is found in all patients in this group.

Group 3.—In the third group are placed patients in whom a biochemical disturbance is found. This group includes persons in whom vitamin A was deficient or did not combine with the visual purple. Several manifestations of vitamin A deficiency may present themselves. Thus one encounters clinical avitaminosis A, with or without xerophthalmia. This entity may manifest itself as a disease of the mucosa of the respiratory tract, as some types of disease of the blood or of the skin or as renal calculi, jaundice or some hepatic dyscrasia. A study of the dark adaptation of such persons often gives a moderately pathologic dark adaptation graph.

HISTORY OF THE STUDY OF DARK ADAPTATION

A brief history of the beginnings of the study of dark adaptation would include the work of Aubert,¹⁶ who in 1865, by using a heated

14. Feldman, J. B.: (a) Dark Adaptation as a Clinical Test, *Arch. Ophth.* **15**:1004 (June) 1936; (b) footnote 12.

15. Percival, A. S.: Light Sense, *Tr. Ophth. Soc. U. Kingdom* **40**:311, 1920.

16. Aubert, H.: Untersuchungen ueber die Sinnesfähigkeit der Netzhaut, *Ann. d. Phys. u. Chem.* **115**:87, 1862.

platinum wire as a light stimulus in a dark room, was the first to study systematically the minimum light visible, or the light threshold. Charpentier¹⁷ in 1880 showed the value of previous light adaptation on the subsequent study of the dark adaptation. According to Hay,¹⁸ Förster in 1873 constructed the first scientific instrument to determine the light threshold and the course of dark adaptation. Since these early dates the literature on the subject has been augmented by various studies made on different phases of dark adaptation with a compilation of the data by Adams.¹⁹

A review of the literature reveals descriptions of some of the better known instruments, the outstanding feature of each being the novel way by which the quality of the light can be controlled throughout an entire study.

1. According to Lythgoe,²⁰ Best used "radiolite" screens for test objects.

2. Derby and his co-workers²¹ used a photometric wedge in a portable instrument or in a projection lantern.

3. Downey²² used "marvelite" disks. These disks are made by impregnating zinc sulfide with radium, over which celluloid disks are placed.

4. Edmund and Clemmesen²³ used a modified Masson disk with Tscherning photometric glasses.

5. Ferree and Rand²⁴ used a projector, with an iris diaphragm to step down the illumination.

17. Charpentier, A.: Sur les variations de la sensibilité lumineuse suivant l'étendue des parties rétinienne excités, *Compt. rend. Acad. d. sc.* **91**:995, 1880.

18. Hay, P. J.: Studies in the Light Sense, *Arch. Ophth.* **39**:160, 1905.

19. Adams, D.: Dark Adaptation: A Review of the Literature, Medical Research Council, Special Report Series, no. 127, London, His Majesty's Stationery Office, 1929.

20. Lythgoe, R. J.: Illumination and Visual Capacities, Medical Research Council, Special Report Series, no. 104, London, His Majesty's Stationery Office, 1926, p. 19.

21. Derby, G. S.; Chandler, P. A., and Sloane, L. L.: A Portable Adaptometer, *Tr. Am. Ophth. Soc.* **27**:110, 1929.

22. Downey, J. W.: Determination of Minimum Light Sense and Retinal Dark Adaptation with Presentation of a New Type of Photometer, *Arch. Ophth.* **2**:13, 1912.

23. Edmund, C., and Clemmesen, S.: On Deficiency of A Vitamin and Visual Dysaptation, Copenhagen, Levin & Munksgaard, 1936.

24. Ferree, C. E., and Rand, G.: Lantern and Apparatus for Testing the Light Sense and for Determining the Acuity at Low Illuminations, *Am. J. Ophth.* **3**:335, 1920.

6. Feldman²⁵ described an instrument containing a neutral filter and a constant light. With this instrument, if the patient recognizes within five minutes the light stimulus and the direction it takes, he is considered to have normal adaptation.

7. Hay¹⁸ employed an adjustable diaphragm with two pairs of Nicol prisms, thus making use of a polarized light in his photometer.

8. Hecht²⁶ used a light in a movable carriage. The amount of light decreases as the carriage recedes.

9. In the Nagel adaptometer²⁷ an Aubert diaphragm is used for fine changes of brightness; three screens, each containing a number of holes, are used to reduce further the original amount of light filtered through three milk glass plates.

10. Percival²⁸ used a black ring on a gray disk, the disk being rotated.

11. The Piper modification²⁹ of the Nagel adaptometer contains two Aubert diaphragms in addition to the screens used by Nagel.

12. Spaeth³⁰ used a mask containing miniature five dice openings, with prisms. The mask is placed in front of the patient's eyes, making it possible to record the dark adaptation in the ordinary examining room.

13. Waite and his co-workers³¹ called attention to Förster's instrument, which makes use of an adjustable diaphragm, and to Nuttings' apparatus, which makes use of a photometric wedge.

These various types of instruments should be sufficient to demonstrate the diverse methods used by various observers to give a range of light and the means by which this factor is controlled.

ESSENTIAL FACTORS IN RECORDING DARK ADAPTATION

The minimum light flux which the eye can see is a function of at least four variables which should be taken into consideration in studies of dark

25. Feldman, J. B.: Instrument for the Qualitative Study of Dark Adaptation, *Arch. Ophth.* **18**:821 (Nov.) 1937.

26. Hecht, S.: The Nature of Foveal Dark Adaptation, *J. Gen. Physiol.* **6**: 113, 1921.

27. Nagel, W. A.: Zwei Apparate für die augenärztliche Functionsprüfung, *Ztschr. f. Augenh.* **17**:201, 1907.

28. Percival, A. S.: Notes on Light Sense, *Tr. Ophth. Soc. U. Kingdom* **42**: 285, 1922.

29. Piper, H.: Zur messenden Untersuchungen und zur Theorie der Hell-Dunkel-Adaptation, *Klin. Monatsbl. f. Augenh.* **45**:357, 1907.

30. Spaeth, E. B.: Clinical Determination of the Light Threshold, *Arch. Ophth.* **11**:462 (March) 1934.

31. Waite, J. H.; Derby G. S., and Kirk, E. B.: Glaucoma. *Tr. Ophth. Soc. U. Kingdom* **45**:310, 1925.

adaptation³² and particularly in the construction of an instrument. They are: (1) the size of light, (2) the brightness of light, (3) the surrounding field and (4) the duration or time the light stimulus acts on the retina.

In my instrument for a qualitative study of dark adaptation I used only the fourth factor as the variable (the duration of the light stimulus acting on the retina). The other three were constant. In the instrument for the quantitative test, which I am now using and which will be explained later, the size and surrounding field are the constants, and both the brightness and the duration of time the light stimulus acts on the retina are the variables.

Size of the Light.—In a study of dark adaptation the rods are principally investigated. Breuer and Pertz³³ have found in this work that the retina is most sensitive at the area of from 10 to 20 degrees from the fovea. The light stimulus of an adaptation apparatus should therefore include this area of the retina. The machine is turned on, and the patient indicates just when a light is seen. An added check on the veracity of the patient is to have him tell the direction which the light stimulus takes. This involves the use of a movable light stimulus, which is highly valuable, and which I have made use of in my qualitative device for dark adaptation study.

Ordinarily, I have found the temporohorizontal segment of the retina the easiest to study^{13a} and indicative of the health of the balance of the retinal tissue in the majority of cases. This is the area usually studied by my larger apparatus for quantitative estimation of dark adaptation. When, however, a visible retinal pathologic process is present, the light stimulus may be placed in a position corresponding with the pathologic area of the retina which it is desirable to investigate.

Brightness of Light.—The instrument should have a wide range of light, with a gradual and constant increase in brightness. Most important, the quality of the light must remain the same throughout its entire range of intensity. When a rheostat is used in a dark adaptation machine, a pure white light of intense brilliancy becomes yellowish when the light is reduced. This reduction by a rheostat alters the quality of the light.

A device in the dark adaptation machine to retain its voltage regardless of whatever other electric machinery is used in the building is a

32. (a) Lythgoe, R. J.: Illumination and Visual Capacities, Medical Research Council, Special Report Series, no. 104, London, His Majesty's Stationery Office, 1926. (b) Cobb, P. W.: Light Sense, *Am. J. Ophth.* **15**:917, 1932.

33. Breuer, H., and Pertz, A.: Ueber die absolute Empfindlichkeit der verschiedenen Netzhautteile im dunkeladaptierten Auge, *Ztschr. f. Psychol. u. Physiol. d. Sinnesorg.* **15**:327, 1897.

worthy refinement. The lamp in the dark adaptation machine should be carefully selected and seasoned.

In the selection of a desirable instrument, the words of Lord Kelvin are to be considered: "If you can measure that of which you speak, and can express it by a number, you know something of your subject; but if you cannot measure it, your knowledge is meagre and unsatisfactory."

The light in the instrument selected should be calibrated. Usually this is done in millilamberts. Since this is essentially an ocular test, it is better to give the light threshold reading in photons.

A photon is a unit of retinal illumination. It is 1 candle per square meter per square millimeter of pupil.

The method of converting millilamberts into photons³⁴ is as follows: $B \times 10a/\pi = I$. B is the brightness in millilamberts; a is the area of the pupil; π is 3.142, and I is the illumination of the retina in photons.

Surrounding Field or Environment of the Eye.—The surrounding field should be one of contrast, such as, for example, the white stimulus on a dark background. This is easily obtained by doing the tests in an absolutely dark room.

Duration or Time the Light Stimulus Acts on the Retina.—In most dark adaptation tests this variable is the only one of the four which is used as the experimental variable, the remaining three being constant. An instrument utilizing "flicker"³⁵ will record in split seconds the time during which the light threshold readings are taken.

Other Features.—The ability to record in the dark the intensity of light threshold used during each test is another valuable feature of a dark adaptation machine.

Noiseless operation is an asset. The comfort of the patient by means of a suitable head and chin rest is to be considered and makes for more valid recordings.

It should always be remembered that the test for dark adaptation is at best a subjective one and that one is always at the tender mercy of the subject examined. The shortcomings are many if care is not utilized. The patient should always be made to understand in advance what is desired of him. Cooperation on the part of the subject is essential. Children and some adults are often apprehensive of an on-coming calamity when taking this test in the dark, or for some unknown reason they give inconsistent answers as to just when they

34. Troland, L. T.: *Apparent Brightness: Its Conditions and Properties*, Tr. Illum. Engin. Soc., 1916, p. 947.

35. Lythgoe, R. J., and Tansley, K.: *The Adaptation of the Eye: Its Relation to the Critical Frequency of Flicker*, Medical Research Council, Special Report Series, no. 134, London, His Majesty's Stationery Office, 1929.

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34. Troland, L. T.: *Apparent Brightness: Its Conditions and Properties*, Tr. Illum. Engin. Soc., 1916, p. 947.

35. Lythgoe, R. J., and Tansley, K.: *The Adaptation of the Eye: Its Relation to the Critical Frequency of Flicker*, Medical Research Council, Special Report Series, no. 134, London, His Majesty's Stationery Office, 1929.

see the light stimulus. Their fears are allayed and much time is saved by having several patients take the test together.

When the preexposure "light adaptation" is incorporated in the dark adaptation machine, more valid results are obtained. This will be explained under "Uniform Preexposure."

THE INSTRUMENT

The instrument I now use in the study of dark adaptation has been constructed on the principles which I have embodied in this paper, relative to the light flux, the comfort of the patient, the accuracy in controlling the quality of the light and the light threshold recordings. This instrument is depicted on figure 1, in which *A*, indicates the chin rest and forehead support; *B*, the light-adapting chamber, which can be pushed out of the way at swivel *C* (the patient's eyes can be seen while being adapted to light); *D*, the stand containing voltage control, assuring a constant voltage to the lamp in lamp house *E*, the lamp being carefully selected and seasoned; *F*, a thumb screw which alters and records the distance from the lamp to the filter *G*; *H*, a pin, one on each side of the light stimulus where the patient's finger is placed, indicating where the patient is to look; *I*, the self-recording table, divided by a pencil line for the right and left eye (the turning of the table alters the intensity of the uniform light only), and *J*, the light house for photometric measurement of the lamp in the lamp house.

Before any studies are made, a photometer inserted in opening *J* should register 22 foot candles when the lamp is placed 20 cm. from the filter by adjusting the thumb screw (*F*). This makes certain of the equality of the photometric value of the lamp for all tests made.

The lamp is carefully selected and seasoned, and the voltage to the lamp is constant. The quality of the light is constant throughout the entire range of illumination. The instrument is portable.

All these features assure the observer of an accurate, easily handled and easily controlled instrument.

TECHNIC OF DARK ADAPTATION STUDIES

Next in importance to a carefully constructed instrument is a uniform technic. In all my studies the following steps are carried out:

1. The history is recorded, and a complete ophthalmologic examination is made.
2. The size of the patient's pupil is regulated.
3. A uniform preexposure to light is used in every case.
4. The patient is told where to fix the eyes during the test.
5. A uniform thirty minute study is used for each eye, records being taken usually every three minutes.
6. A dark adaptation graph is plotted.

History and Ophthalmologic Examination.—Dark adaptation, according to Traquair,³⁶ is the response to the reaction of the receiving apparatus, i. e., the visual purple, the choroid and the bacillary layer of the retina. An ophthalmoscopic examination of each patient previous to studying the dark adaptation makes it possible for one to divide those with organic diseases (glaucoma, choroiditis and retinitis pigmentosa), in whom the ocular pathologic process is usually evident, from those

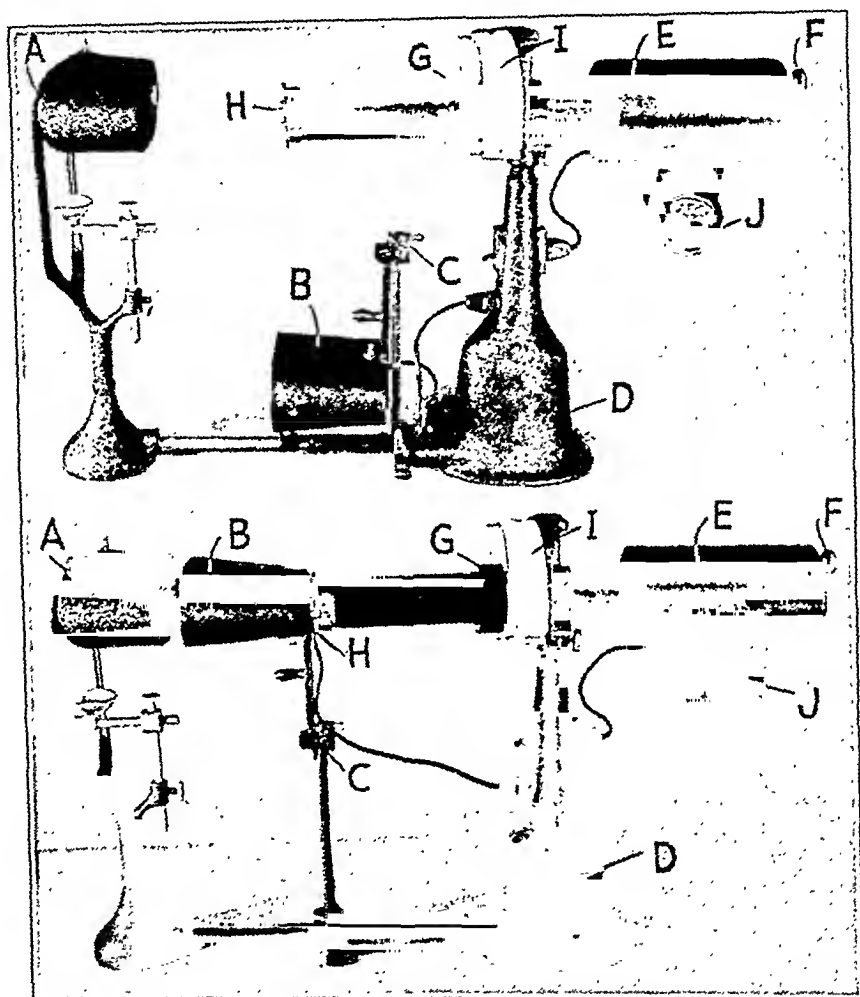


Fig. 1.—Machine for the study of dark adaptation.

with functional diseases (vitamin A deficiency), in whom the fundi are always normal. This aids in a correct classification of the graphs when they show dysaptation.

To give a concrete example: A. R., a 6 year old undernourished boy, was found to have choroiditis on ophthalmoscopic examination. If the ophthalmoscope had not revealed choroiditis, a diagnosis of dysaptation due to avitaminosis A might have been made from the appearance

36. Traquair, cited by Percival.²⁸

of the child. The patient then would have been placed in group 3, whereas the correct classification is group 2.

Another case which shows the usefulness and importance of examinations of the fundi follows: R. S., a 60 year old man with renal calculi, was found on ophthalmoscopic examination to have retinal arteriosclerosis. Without the knowledge of the ophthalmoscopic findings, the patient would be placed in group 3³⁷; however, the proper classification is group 2.

Regulation of the Size of Patient's Pupils.—The size of the pupil plays an important role in the result obtained in taking the light threshold. In a patient with a previous iritis the synechia cut down the amount of light which strikes the retina. Even healthy pupils do not all dilate to the same extent in the dark room. When dark adaptation is recorded with the eye near the instrument, the accommodation necessary may slightly contract the pupil. Merrill and Oaks³⁸ have noted that the light sense is enhanced proportionally to the square root of the retinal area. Derby and his co-workers³⁹ have shown that an 8 mm. pupil admits sixteen times as much light as a 2 mm. pupil, thus inducing an error of 1,600 per cent if the pupillary size were not considered. They cited Møller as being the first of the Copenhagen group of investigators who took into account the size of the pupil as a factor in their investigation. Hecht,²⁶ recognizing the usefulness of knowledge of the size of the pupil, first used an artificial pupil, but finding this to be impractical he calculated the measurement of the pupil according to the formula of Reeves.⁴⁰

Dilation of the pupil by a 1 per cent solution of atropine needs only casual mention. The increased size of the pupil necessitates a number of extra filters to step down the light for the light threshold reading. The use of a mydriatic may also subject the patient to glaucoma if there is any tendency to this condition. I have tried using an artificial pupil, but with little success. The slightest movement of the patient's eyes makes visibility impossible. The photographing of the pupil by infra-red photography in the dark room was also abandoned. It is expensive, and sometimes a small amount of uveal pigment in the region of the pupil, which photographs black, gives the impression of a larger pupil. At best it does much to complicate a simple problem. The most effec-

37. Ezickson, W. J., and Feldman, J. B.: Signs of Vitamin A Deficiency in the Eye Correlated with Urinary Lithiasis, *J. A. M. A.* **109**:1706 (Nov. 20) 1937.

38. Merrill, H. G., and Oaks, L. W.: The Light Sense: Its Importance and Tests, *Am. J. Oph.* **9**:38, 1926.

39. Derby, G. S.; Chandler, P. A., and O'Brien, M. E.: Further Studies on the Light Sense in Early Glaucoma, *Tr. Sect. Ophth., A. M. A.*, 1928, p. 37.

40. Reeves, P.: Rate of Pupillary Dilatation and Contraction, *Psychol. Rev.* **25**:330, 1918.

tive and easiest method consists of the use of a 1 or 2 per cent solution of pilocarpine nitrate to contract the pupil. Ordinarily, 1 drop every fifteen minutes for three doses is ample to contract the normal pupil to 1 mm. in size in the great number of cases. Sometimes I augment the pilocarpine by substituting a 1 per cent solution of physostigmine salicylate for the last instillation of pilocarpine. No untoward effect should follow this procedure. To date I have employed this method in about four thousand studies of dark adaptation, without any untoward effect. The method was first suggested by Derby and his co-workers and was used throughout all of their investigations. After contracting the pupil, Derby, following the suggestion of Reeves, calculated all data to a 5 mm. pupil for each eye examined. This was done so that the records of one patient could be easily compared with those of another. It was accomplished by multiplying the number of millilamberts obtained at the threshold reading by 2.50 for an 8 mm. pupil, by 1.33 for a 6 mm. pupil, by 1 for a 5 mm. pupil, by 0.66 for a 4 mm. pupil and by 0.16 for a 2 mm. pupil.

Uniform Preexposure.—Light adaptation, to precede the dark adaptation studies, is indicated to achieve more reliable results. In the beginning of this paper dark adaptation was explained by citing the inability of a person to see the seats in the theater for a short while after he came into the theater from the sunny street. The physiologic explanation of this phenomenon is that the sun bleached out the visual purple. When the person entered the dark theater, the vision improved in direct proportion to the regeneration of the visual purple.

In order to determine results which are consistent and which may be compared with the results of other workers, it is best to give all persons studied the same amount of preexposure to light.

Instead of preexposure of the eyes to light, the patient can be kept in a dark room for from one-half to one hour before dark adaptation studies are begun. This would, however, unduly prolong the examination.

Preexposure, or light adaptation, can also be accomplished by having the patient look at the clear blue sky on a bright sunny day. The shortcomings of preexposure to daylight are, of course, clearly evident when one considers the difficulty of light adaptation on a cloudy day or at night. A better and more accurate plan is to have the entire study made without the subject leaving his seat.

Lohman⁴¹ calculated that two minutes is the exact time for an eye to become fully adapted to light. I have found this to be correct by practical experience, and to make certain still further that the light

41. Lohman, W.: Ueber Helladaptation, Ztschr. f. Psychol. u. Physiol. d. Sinnesorg. 41:290, 1906.

adaptation is not undertimed I used three minutes in all cases. Some investigators use as high as ten minutes.

The instrument should have as brilliant and intense a light for pre-exposure as can be borne comfortably by the patient. A device in the apparatus making it possible to see if the subject is continually keeping the eyes open during preexposure is important. Often a patient will deliberately keep his eyes closed. The preexposure is for the purpose of bleaching out the visual purple. If this is not accomplished to the same extent and intensity for all patients, one cannot expect comparable data.

The change from preexposure (light adaptation) to dark adaptation should be sharp and clearcut.

Fixation of Eyes During the Dark Adaptation Test.—The question arises as to whether the patient should be told where to look when taking the dark adaptation test. It is the opinion of some observers that after fifteen minutes of dark adaptation the sensitivity of the rods and cones are equal and that the direction of gaze does not alter the threshold. Obviously, when only one reading is taken, and that before fifteen minutes, it is essential that the patient know where to look to see the light stimulus. On the other hand, when many readings are taken, directing the patient just where to look will yield a dark adaptation reading for the particular retinal area desired. Fixation may be accomplished by asking the patient to look at a minute red stimulus, of a wavelength of 6,500 angstroms or over.

An improvement over the red dot of light for fixation is to have the patient place the finger where it is desired that he fix his eyes. This involves the use of the muscle sense and makes the patient feel that he is taking an active and responsible part in the study.

Uniform Interval and Duration of Study of the Light Threshold.—The more often the dark adaptation readings are taken, the quicker the ultimate light threshold is obtained. In order that my graphs may be compared easily, I study each patient every three minutes for thirty minutes.

It is best to take the three minute readings of one eye and then the other, and so alternate, giving no preference to either one or the other eye.

It is worthy of note that summation does occur in dark adaptation; i. e., unlike cone threshold function, the minimum light threshold is lower when both eyes are used than when only one is tested. This fact is made use of in my qualitative device.²⁵

The curves of sensitivity of the two eyes of a normal subject during dark adaptation are usually similar but not always definitely the same.

*Plotting of the Dark Adaptation Graph.*⁴²—Charpentier¹⁷ and Jones⁴³ give twenty minutes as sufficient time for practical purposes for testing light sensitivity in a dark room. I have found sensitivity during dark adaptation tests up to thirty minutes. In some cases the sensitivity is definitely normal within twelve or fifteen minutes. When this occurs, it is not necessary to continue the readings. On occasion, I have studied the light sense of persons with pathologic conditions from one to four hours, at the end of which time the readings still continued to show pathologic dark adaptation. The readings of the first few three minute intervals are high, after which the sharp drop denoting the marked increase in sensitivity occurs. The eye of the great majority of normal persons becomes so sensitive to light that readings from then on are but a minute fraction of the original light just perceived by the patient.

The tabulations of the amount of light on my graphs are given as the ordinates, and the time of reading intervals, as the abscissas.

A series of dark adaptation readings for a normal person, when plotted on a graph, will produce a curve resembling a hyperbola. This hyperbola serves as a standard for the normal subject and enables one to compare the results obtained with those of other studies made by the same and other observers. Plotting a reading adds objective qualities to a subjective test. The observer can quickly recognize when the answer of the patient is incorrect. A sudden loss of sensitivity at one reading followed by a quick recovery on the following reading denotes inattention (fig. 2).

Just as in perimetry, characteristic changes in the visual field are associated with definite ocular or neuropathologic conditions, specific dark adaptation graphs have been associated with definite functional or organic pathologic involvement of the deeper retinal structures (rods, visual purple and choroid).

The following charts will, I believe, assist in illustrating the relative merits of the plotted graph over tabulated figures of light measurements in the individual cases.

Figure 2 gives the characteristic curve of the dark adaptation study of a normal eye. The fifteen minute reading of the right eye shows the sudden decrease in sensitivity, as noted by the increased amount of light necessary at that reading. This is not pathologic but is caused by inattention on the part of the patient. The graph shows the normal range to be between 0.000010 and 0.000100 photons. Moderate functional disturbances yield a terminal reading at thirty minutes between

42. Feldman, J. B.: A Graph for Recording Results in Dark Adaptation, *Am. J. Ophth.* 19:510, 1936.

43. Jones, cited by Lythgoe.²⁰

0.000100 and 0.000500. I have often found a graph similar to figure 3 in cases of vitamin A deficiency. Quite often one sees a slight loss of sensitivity during the plotting of the dark adaptation graph. To this upturn on the graph I have given the name "rod suppression."

I have often obtained readings of between 0.000500 and 0.010000 photons in cases of severe glaucoma, choroiditis or arteriosclerosis

Vision		
	O. D.	O. S.
S. C.	6/6	6/6
C. C.		

T. = M. =	Millilamberts Photons	Millilamberts Photons
3	.00060 .02150	.00561 .01406
6	.00469 .01170	.00325 .00813
9	.00240 .00600	.00130 .00323
12	.00073 .00183	.00102 .00255
15	.000098 .000245	.000067 .000167
18	.000033 .000002	.000029 .000073
21	.000015 .000037	.000022 .000055
24	.000015 .000037	.000015 .000037
27	.000012 .000031	.000015 .000037
30	.000014 .000035	.000015 .000037
35		
40		
45		
50		
55		
60		

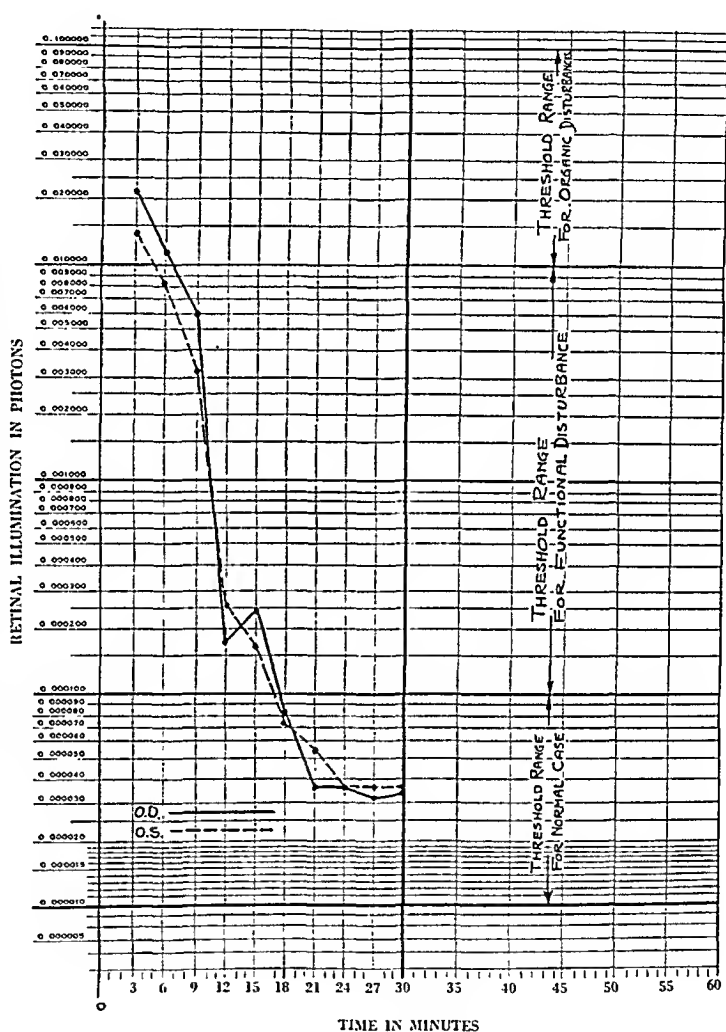


Fig. 2.—Dark adaptation graph for the normal eye, recorded in photons. The sudden rise for the right eye at fifteen minutes denotes inattention. Millilamberts and photons are recorded in the table at the left. To the right are shown the various threshold ranges of dark adaptation readings.

(fig. 4). The threshold range (i. e., the various three minute intervals of dark adaptation studies) for organic disturbances has been above 0.010000 photons (fig. 5). "Total suppression" sometimes may occur, wherein the patient is unable to see the light of the apparatus for several readings. "Total and absolute suppression" is the term used when

the patient is unable to see the light for the entire thirty minutes of study. Such readings are often found in cases of retinitis pigmentosa and choroideremia.

RESULTS

The various results which I have obtained by the quantitative machine (the latest device, the photograph of which is here shown)

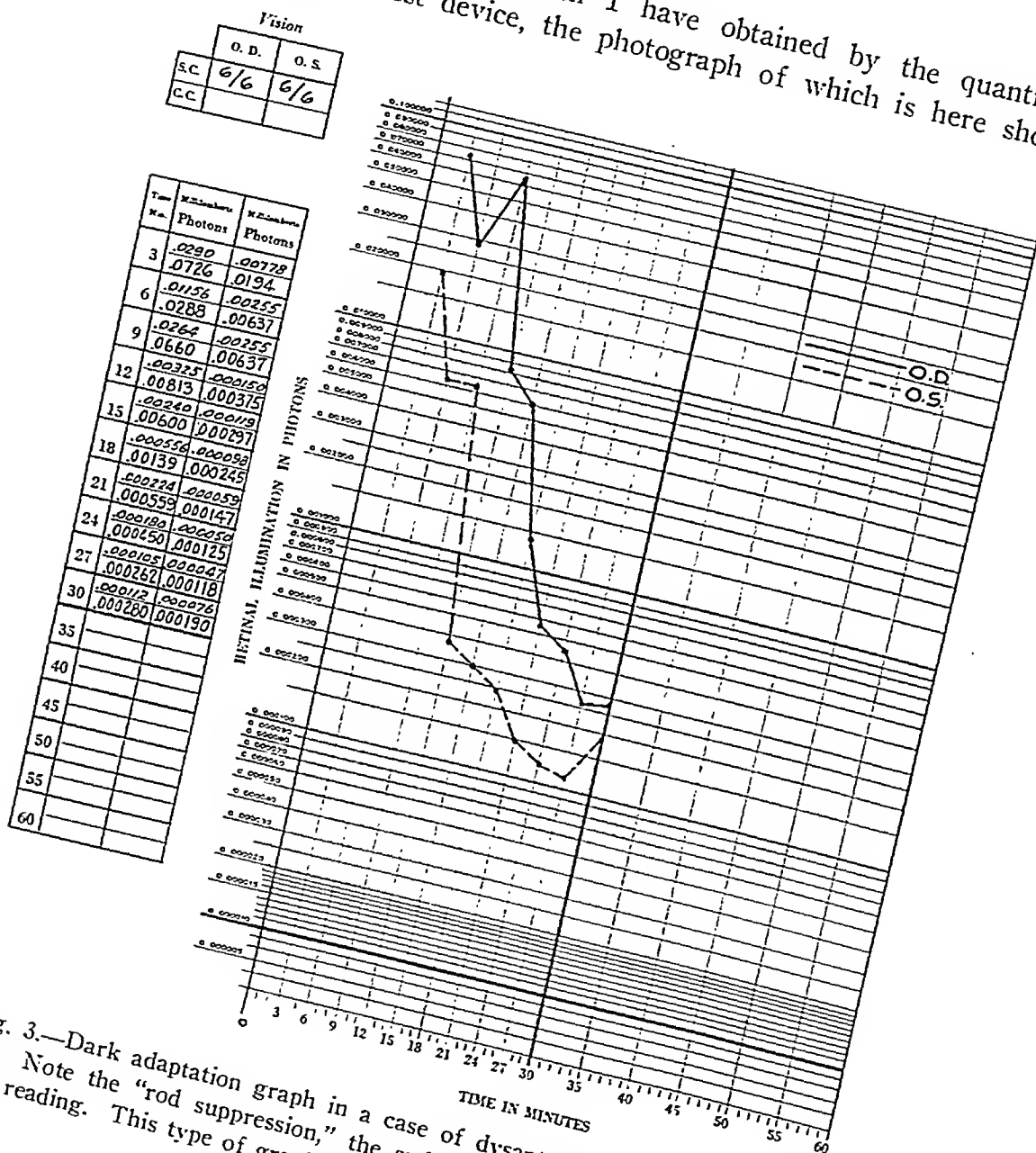


Fig. 3.—Dark adaptation graph in a case of dysadaptation associated with renal calculi. Note the “rod suppression,” the sudden loss of sensitivity at the thirty minute reading. This type of graph is common.

was reported in my previous papers.⁴⁴ Four thousand eyes have been examined to date. The results have been consistent and merit a continuation of my studies.

44. Feldman, footnotes 12 and 14a.

While there is no doubt that the tonometer and perimeter are far more useful as a diagnostic measure in cases of glaucoma, I have found two cases of early glaucoma in which the tension and the visual fields were normal, cupping was suggestive and the results of the dark adaptation study definitely showed that the eyes were not normal and

	Vision	
	O. D.	O. S.
S.C.	6/9-2	FINGERS At 1 Ft
C.C.		

Time	Milliambers Photons	Milliambers Photons
3	.0287 .0706	.0187 .0468
6	.0130 .0325	.0116 .0279
9	.0112 .0280	.0305 .0762
12	.00612 .0153	.0227 .0562
15	.00325 .00812	.0154 .0383
18	.00364 .00910	.0157 .0392
21	.000338 .000843	.0116 .0289
24	.000228 .000571	.00538 .0134
27	.000159 .000399	.00514 .0128
30	.000342 .000856	.00612 .0153
35		
40		
45		
50		
55		
60		

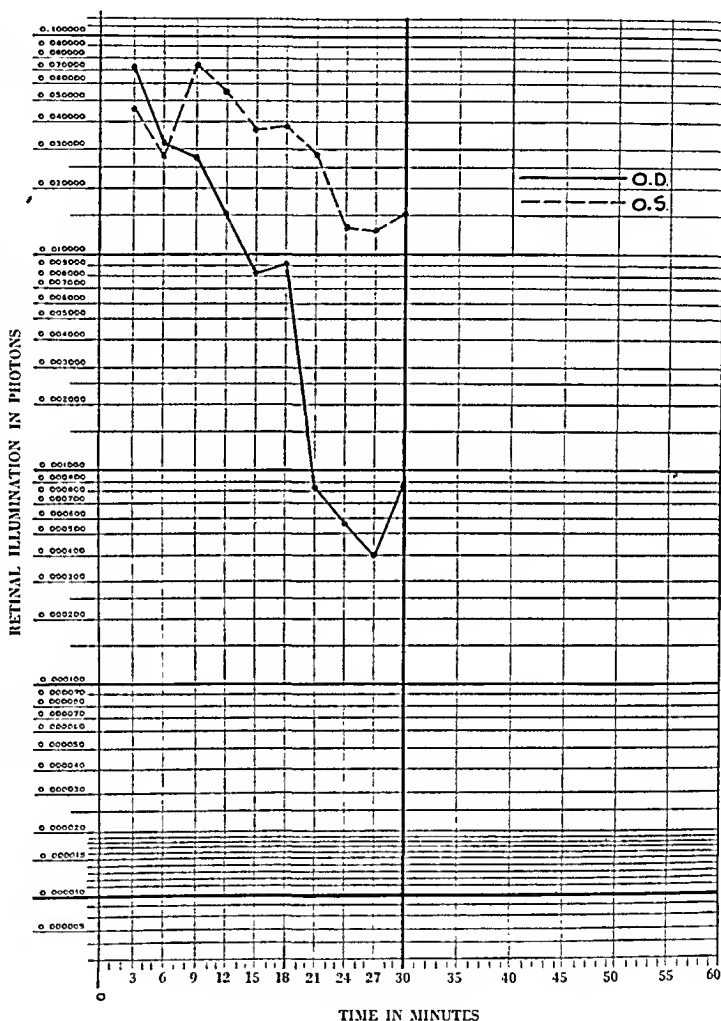


Fig. 4.—Dark adaptation graph in a case in which a provisional diagnosis was made of chronic congestive glaucoma of the left eye (tension 77) and possible simple glaucoma of the right eye (tension, 20). The two curves show the dark adaptation seen in the different stages of the disease. This study was done on the patient's admission to the hospital. After a few days the provisional diagnosis was verified.

a guarded prognosis should be given. The ensuing course in these cases verified my opinion. In both patients a frank glaucoma developed.

With the qualitative device,²⁵ normal dark adaptation readings were obtained for patients with alcoholism (eleven patients), arthritis of

the knee, asthma, choked disk, slight cold and hay fever, diseased tonsils, drug addiction, gonorrhea (seven patients), an infected finger, interstitial keratitis, a low intelligence quotient (ninety patients), sclerosing keratitis, syphilis (six patients) and squint (all types). Pathologic dark adaptation readings were obtained for patients with acute severe infection, arteriosclerosis, cervical adenitis, choroiditis, a high degree

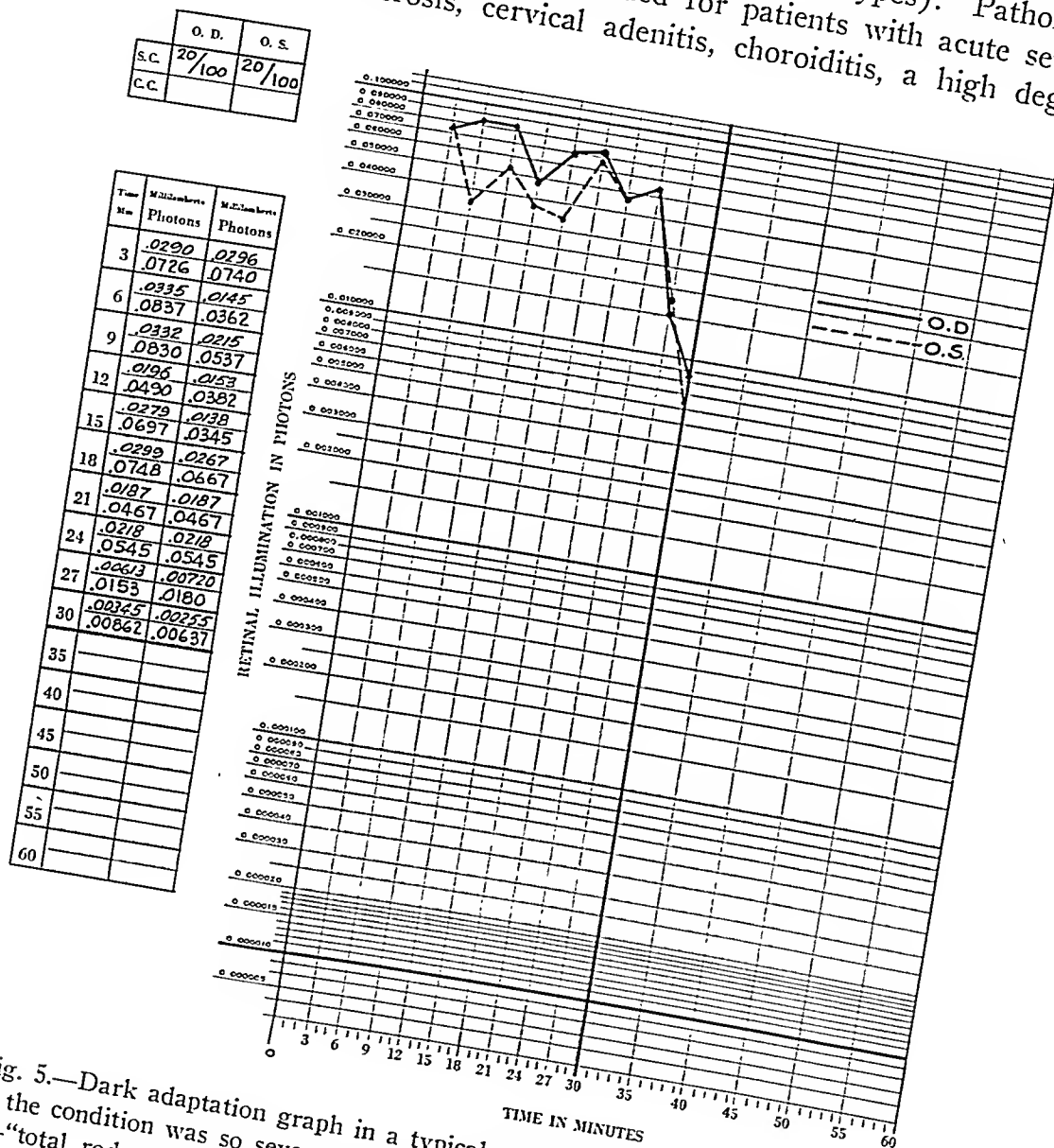


Fig. 5.—Dark adaptation graph in a typical case of retinitis pigmentosa. Sometimes the condition was so severe that the patient could not see any light for some time—"total rod suppression."

of myopia (three patients), hypertension and diabetes, hypertension and renal disease, renal calculi, sinus disease and thyroid disease. Such results were also obtained for mothers who had been nursing their children for four months, for women who were six months pregnant and for three persons who were microscopists. Six hundred and fifteen

patients were examined at three different institutions; a total of 12 per cent showed dysaptation. This study was undertaken by the ophthalmic department, St. Christopher's Hospital for Children in Philadelphia.

A few patients gave questionable results; for example, normal dark adaptation was found in one patient with choroiditis and chorioretinitis. This can be explained in this manner: Since both eyes are open during the test with this instrument, the patient saw the light stimulus with the good eye, and therefore the result was normal. A preliminary examination of the fundus, of course, aids in evaluating the patient's response. With one eye examined at a time and the light stimulus placed so as to encompass the involved choroidal area, the test would, no doubt, have shown a pathologic condition. In one of the institutions twenty patients had pathologic dark adaptation. The results of the ocular examination were negative. Under the assumption that this dysaptation was due to vitamin A deficiency, each patient was given 20,000 units of vitamin A per day. After six weeks, eighteen patients showed normal dark adaptation. Two patients showed no improvement.

SUMMARY AND COMMENT

Dark adaptation is defined.

The von Kries theory is briefly described, as is also the physiologic explanation for day and night vision and their relation to dark adaptation. Mention is made of the history of dark adaptation studies. The importance of dark adaptation is noted as a test for certain pathologic conditions of the eye, such as glaucoma and arteriosclerosis. It gives information as to the response of the rods and the visual purple to light. It is, therefore, quite useful preoperatively when an opacity of the lens makes an ophthalmoscopic examination impossible.

When persons with vitamin A deficiency or diseases believed to be the result of avitaminosis A show a diminished or total loss of regeneration of the visual purple, it is evidenced by a pathologic dark adaptation.

All patients who are to be subjected to a study of the dark adaptation are divided into groups, depending on which of the following factors is interfered with: (1) physical, (2) physiologic and (3) biochemical. The grouping is not necessarily a sharp one, and a patient may be placed in more than one group.

The fundamentals necessary for a correct instrument for recording dark adaptation are discussed, as to the range of light, size of light stimulus and, most important, the retention of the quality of the light stimulus, regardless of how low the intensity of light becomes (i.e., the wavelength of the light must not be altered). Reducing the intensity of light by altering the current in the lamp is not permissible.^{32b}

The minimum light visible is best calibrated either in lambert fraction or preferably in photons, since this is primarily an ocular problem. Noiseless operation of the apparatus is an asset. The proper technic is given.

The value of ophthalmologic examination in each case in which dark adaptation is to be studied is stressed, as is also the size of the pupil in affecting the tabulation of the light sensitivity.

The various methods of controlling the size of the pupil are given.

Preexposure of the dark-adapted eye to light is recommended for the purpose of starting all examinations in a uniform manner. The advantage of preexposure to artificial light over preexposure to sunlight is given.

Attention is called to the desirability of absolute darkness in doing dark adaptation studies when certain types of instruments are used. The advisability of being able to record notations of both the time and the amount of light used in the dark room is noted.

Much time is saved by having the patient fix his eye at a certain point while the studies are being made.

A new instrument for recording dark adaptation is described.

There is a tendency to the production of rather characteristic graphs in certain diseases.

Poor dark adaptation has been noted by many observers to be of great importance in connection with the large number of automobile and aircraft accidents caused by acquired night blindness. A compulsory examination of those who drive at night might disclose any tendency to beginning night blindness, thereby proving of practical value in the prevention of the appalling accidents occurring in night travel.

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REMOVAL OF CATARACT BY ASPIRATION

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DETROIT

Any one moderately familiar with ophthalmic literature cannot help but be curiously impressed by the prolific number of reports regarding the efficiency of, and fine results obtained with, a multitude of different surgical technics employed for the removal of cataract. It is difficult for any one to judge impartially the best among a dozen or more different operative procedures when one is not equally familiar by adequate experience with all of them. Arruga¹ recently pointed out that an operator who possesses a practice of several years with a technic which has become his routine is not easily convinced of the advisability of changing it without reasons and facts having considerable weight. It is necessary that the technic which he does not use present advantages such that they compensate for the trouble involved in changing habits already acquired.

While the technic of cataract extraction does remain largely a matter of individual training, preference and experience among ophthalmic surgeons, it is nevertheless generally recognized that some types of cataract are more easily and more efficiently removed by some one method than by others. Clapp² mentioned briefly the possibility of applying a limited number of different surgical technics to the same type of cataract but inferred that the choice of method lies chiefly in the individual skill of the operator and not in the type of cataract. It seems not entirely illogical that the attainment of some measure of skill should be taken for granted in those trained to do surgical work on the eye and that more emphasis should be placed on the types of changes in the lens and the efforts to determine which particular technic is best suited to each of them. Moreover, it is presumable that the time will eventually come when a standardized general ophthalmologic training will permit one to look beyond the individuality of the surgeon and to give more consideration to the ocular changes themselves in determining the most desirable type of surgical treatment for each cataract. In

1. Arruga, H.: Les avantages et les inconvénients de l'extraction totale de la cataracte, *Bull. et mém. Soc. franç. d'opht.* **48**:218, 1935.

2. Clapp, C. A.: *Cataract Etiology and Treatment*, Philadelphia, Lea & Febiger, 1934.

a recent paper on cataract Wright³ not only approached the matter from this standpoint but even attempted to assign to each of several types of cataract the particular surgical technic that he believed the most appropriate.

At any rate, it seems rational that entirely aside from differences in individual ability there are certain characteristics inherent in certain types or stages of pathologic ocular changes which make some surgical procedures more efficiently applicable than others.

From recent comprehensive reports,⁴ from personal experience and from the studies of the results in persons operated on over a period of several years I have come to the conclusion that the factor of individualism in surgical work is somewhat overrated and that after all it is the proper application of the most efficient technic in each case considered from the point of view of the type of ocular change present that is most important. For example, a modification of the Barraquer technic⁵ has been successfully adapted to the extraction of traumatic, dinitrophenol and morgagnian cataracts and to senile nuclear and senile cortical cataracts in practically all stages of incipency and maturity. However, other technics have been employed without hesitancy for certain types of cataract when the circumstances appeared to indicate the advisability.

The particular types of cataract on which this report is based were selected on the basis of a relative lack of sclerosis of the nucleus of the lens and a certain degree of increased fluid content or softness of the pathologic lens structure, as determined chiefly with the slit lamp. In other words, an attempt was made to apply the technic only to various types of soft cataract. A lens in which the pathologic change is largely an autolysis of the lens fibers, with imbibition of fluid and little or no nuclear sclerosis, is best suited to removal by this method. However, the most important factor in selecting a suitable type of cataract for this surgical technic is the absence of a large hard nucleus; for even if the various strata of the lens are compact and contain no more than a normal amount of fluid, the technic still provides for further softening and efficient removal. The particular types of cataract encountered in this series are indicated in the table.

3. Wright, R. E.: Lectures on Cataract, *Am. J. Ophth.* **20**:1 (Jan.); 119 (Feb.); 240 (March); 376 (April) 1937.

4. de Grósz, E.: L'extraction de la cataracte d'après 15,000 opérations, *Arch. d'ophth.* **53**:161 (March) 1936.

5. Blaess, M. J.: Barbiturate Therapy and Cataract Surgery in Parkinsonism, *J. Iowa M. Soc.* **27**:571 (Nov.) 1937. Wolfe, O., and Blaess, M. J.: The Barraquer Intracapsular Cataract Operation, *Eye, Ear, Nose & Throat Monthly* **14**:200 (July) 1935.

Data on Cases of Cataract in Which Aspiration Technic Was Used

Patient	Age	Sex	Eye	Condition of Crystalline Lens	Best Corrected Vision Before Operation	Schedule of Operative Treatment	Date of Refraction and Visual Result
1	5	M	R	Congenital embryonic perinuclear cataract	Too young for refraction	8/10/34: Dissection of anterior capsule 8/16/34: Aspiration 9/26/34: Dissection of posterior capsule	9/25/34: 10/200* 2/ 6/35: 20/20
2	5	M	L	Congenital embryonic perinuclear cataract	Too young for refraction	10/31/34: Dissection 11/14/34: Aspiration; dissection of posterior capsule	2/ 6/35: 20/20
3	25	M	R	Hereditary posterior subcapsular cataract	20/200	10/12/34: Dissection 10/15/34: Aspiration; dissection of posterior capsule	11/ 1/34: 20/15
4	25	M	L	Hereditary posterior subcapsular cataract	20/100	10/18/34: Dissection 10/23/34: Aspiration; dissection of posterior capsule	11/ 1/34: 20/15
5	13	M	R	Congenital embryonic perinuclear cataract	2/200	4/11/35: Dissection 4/16/35: Aspiration; dissection of posterior capsule	5/17/35: 20/70 2/ 5/36: 20/20
6	13	M	L	Congenital embryonic perinuclear cataract	20/200	4/26/35: Dissection 5/ 3/35: Aspiration; dissection of posterior capsule	5/17/35: 20/70 2/ 5/36: 20/20
7	10	F	L	Congenital embryonic perinuclear cataract	Finger counting	4/11/35: Dissection 4/18/35: Aspiration; dissection of posterior capsule	5/17/35: 20/70 2/ 5/36: 20/30
8	10	F	R	Congenital embryonic perinuclear cataract	Finger counting	4/26/35: Dissection 5/ 1/35: Aspiration; dissection of posterior capsule	5/17/35: 20/70 2/ 5/36: 20/30
9	38	F	R	Soft cortical cataract	Hand movement	3/20/35: Dissection 4/ 5/35: Aspiration; dissection of posterior capsule	5/ 4/35: 20/30 5/10/35: 20/20
10	38	F	L	Soft cortical cataract	8/200	4/15/35: Dissection 4/20/35: Aspiration; dissection of posterior capsule	5/ 7/35: 20/30
11	25	F	L	Complicated cataract; intumescent lens and secondary glaucoma	Hand movement	4/ 1/35: Dissection 4/ 5/35: Aspiration 4/11/35: Dissection of posterior capsule	4/22/35: Hand movement; good central opening with fundus plainly visible; old disseminated chorioiditis involving macular area

[illegible]

Data on Cases of Cataract in Which Aspiration Technic Was Used—Continued

Patient	Age	Sex	Eye	Condition of Crystalline Lens	Best Corrected Vision Before Operation	Schedule of Operative Treatment	Date of Refraction and Visual Result
26	44	F	L	Dinitrophenol cataract	Hand movement	7/14/36: Discission 7/17/36: Aspiration; discission of posterior capsule	8/ 6/36: 20/20 10/14/36: 20/15
27	44	F	R	Dinitrophenol cataract	20/200	7/27/36: Discission 7/29/36: Aspiration; discission of posterior capsule	8/18/36: 20/50 10/14/36: 20/20
28	29	F	R	Parathyroid tetany cataract (after thyroidectomy)	Hand movement	9/24/36: Discission 9/28/36: Aspiration; discission of posterior capsule	11/16/36: 20/40
29	29	F	L	Parathyroid tetany cataract (after thyroidectomy)	Finger counting	10/ 6/36: Discission; aspiration Discission of posterior capsule	Postoperative Iridocyclitis 11/16/36: 20/30
30	15	M	R	Myopia gravis (no cataract)	20/100	10/ 8/36: Discission; aspiration Discission of posterior capsule	10/20/36: 20/50
31	27	F	R	Keratoconus and cortical cataract	Finger counting	8/21/35: Discission 8/26/35: Aspiration	9/ 3/35: 20/100
32	13	F	R	Congenital embryonic perinuclear cataract	Hand movement	11/28/36: Discission 12/ 4/36: Aspiration; discission of posterior capsule	12/28/36: 20/200
33	13	F	L	Congenital embryonic perinuclear cataract	20/100	12/11/36: Discission 12/16/36: Aspiration; discission of posterior capsule	12/28/36: 20/30
34	6	F	L	Left congenital circumscribed posterior capsular cataract; left microphthalmos and agenesia	Finger counting	11/27/36: Discission 12/ 5/36: Aspiration; discission of posterior capsule	12/28/36: 20/100*
35	34	F	R	Dinitrophenol cataract	Hand movement	12/11/36: Discission 12/13/36: Aspiration 1/ 8/37: Discission of posterior capsule	1/12/37: 20/20
36	34	F	L	Dinitrophenol cataract	Finger counting	12/23/36: Discission and aspiration 1/ 5/37: Discission of posterior capsule	1/12/37: 20/20
37	31	M	R	Partial traumatic cataract	Hand movement	4/22/37: Discission 4/26/37: Aspiration; discission of posterior capsule	8/26/37: 20/40 11/ 7/37: 20/20

* The patient was illiterate.

The data for all cases in which this surgical technic was attempted during a period of three years are included in the table. No case has been omitted in which the operation was performed by this particular method in the ophthalmologic service of the Evangelical Deaconess Hospital during this period. These facts are important because they enhance the value and reliability of the statistics and bear out some of my contentions. I merely wish to present a review of my actual experiences with an aspiration technic used on a carefully selected series of 37 eyes in order to obtain a critical survey of the results and to show that this technic deserves wider recognition and consideration. It is not described in any of the recent books dealing with cataract and is only briefly mentioned in one recent text.⁶

The surgical technic employed is a modification of the Teall method.⁷ A number of minor but original changes have been made and some new and interesting maneuvers have been incorporated into the technic as employed in this series and described here.

It was primarily the advent of the Hildreth lamp,⁸ an incident of no little importance, that brought new possibilities of a much wider range of usefulness and efficiency to the aspiration technic. The absorption of ultraviolet rays by the crystalline lens and the resulting characteristic appearance of the lens substance reveal its presence even in minute quantities and fragments. This permits the removal of the lens substance to an extent that heretofore had always been hoped for but seldom attained. Irrigation of the anterior chamber is unnecessary with this technic. It leaves nothing to guesswork and permits the surgeon to carry the operation of the removal of the softened lens material to a known and satisfactory degree of completion. Practically no dependence is placed on the faculties of absorption, the injurious and destructive effects of prolonged phacoanaphylactic inflammatory reaction thereby being avoided and the incidence of after-cataract, synechia, atrophy of the iris, and postoperative glaucoma being reduced. The technic may be carried out in one, two or three steps, depending on the individual circumstances in each case.

6. Atkinson, D. T.: *External Diseases of the Eye*, Philadelphia, Lea & Febiger, 1937.

7. Wood, C. A.: *A System of Ophthalmic Operations*, Chicago, Cleveland Press, 1911. Dean, F. W.: *Operation for Congenital and Juvenile Cataract*, *Tr. Am. Acad. Ophth.* **31**:261, 1926.

8. The Hildreth lamp is a carbon arc lamp designed for ocular ultraviolet illumination, so that prolonged exposure of the operative field does not result in a burn, as would be the case with a more intense therapeutic lamp. I know of no other lamp made for this specific purpose. It has a quartz lens system, including a focusing lens. It was mentioned by W. A. Fisher (*Senile Cataract*, ed. 3, Chicago, H. G. Adair Printing Co., 1937, pp. 135-137).

The first step consists of dissection of the anterior capsule and breaking up of the lens structure. The second step consists of aspiration of the softened lens substance, and the third step, of dissection of the posterior capsule. A general operating lamp, which provides mixed or white light, and a Hildreth lamp, which provides ultraviolet rays, are focused on the operative field in such a way that the type of illumination is readily interchangeable, so that on instant notice either one or both may provide the illumination.

The patient is carefully prepared for operation under strictly aseptic hospital routine. It is important that the pupil be widely dilated at the beginning of the surgical treatment and kept dilated until after the last step is completed.

TECHNIC

Anesthesia is obtained by from four to six instillations of 5 per cent solution of cocaine hydrochloride at five minute intervals. With small children, an intravenous anesthetic, such as evipal sodium, may be used. Inflammable inhalation anesthetics are contraindicated in the presence of the exposed heated carbons of the Hildreth lamp. The operation is started under white light. The eyeball is fixed by seizing a fold of the conjunctiva below the cornea with Green's fixation forceps. A dissection knife with a short broad blade is inserted through the cornea into the anterior chamber from the temporal limbus. Multiple broad cross lacerations involving all portions of the anterior capsule are then made by wide sweeping excursions of the knife. One must be cautious not to injure the iris or the posterior capsule at the thinner portion of the lens near the equator. After the anterior capsule has been considerably frayed, the blade of the knife is inserted more deeply into the substance of the lens, and the latter is broken up by the shorter movements of the broad portion of the knife blade held at an acute angle. This is best accomplished by short circular movements of the knife blade in successive small segments of the lens and permits aqueous to come in contact with the remotest portions of the naturally hygroscopic lens material. Care must be taken not to injure or lacerate the posterior capsule or to tear the zonular fibers, as this might disturb the vitreous and permit lens debris to become mixed with it. When the lens has been thoroughly broken up, the dissection knife is withdrawn and the eye is illuminated with the ultraviolet rays, while the white light is removed. In this way one can readily determine the extent to which mechanical destruction of the lens structure has been carried out. Two per cent atropine ointment is instilled, and the eyes are bandaged. In some cases in which an intumescent cataractous lens is extremely fluid, the second step in the surgical removal is carried out immediately after dissection.

Usually a variable period of time (from one to several days, depending on the fluid content of the cataractous lens) is permitted to elapse, during which the lens substance imbibes aqueous fluid which has been brought into contact with it. The broken lens material gradually becomes swollen and protrudes into the anterior chamber, where fragments of various size gather in irregular masses. At the same time there goes on a mechanical mixing or dissolving of lens protein in aqueous, so that the latter gradually assumes a clouded or milky appearance.

If nothing further were done, this process of liquefaction would be followed by natural removal of the lens material, a trifold process involving drainage through the usual channels of the anterior segment by phagocytosis and by tissue absorption.

This is a slow and complicated biologic reaction, often involving a severe phaco-anaphylactic iridocyclitis, which is destructive to the iris and eventually results in extensive atrophy of the iris, adhesions and a dense proliferative after-cataract. These are precisely the destructive and vitiating changes that the aspiration technic is specifically designed to obviate.

When the lens material has become softened, swollen and mixed with aqueous, the second step in its removal is carried out. The period of time required for adequate liquefaction, dissolution and autolysis depends to a large extent on individual circumstances. In most cases from one to several days were required to permit adequate liquefaction. In a few cases the intra-ocular pressure became moderately elevated during this period, but in no case did secondary glaucoma become a serious menace, and in a few cases in which it appeared it was entirely and permanently relieved after the aspiration of the lens débris.

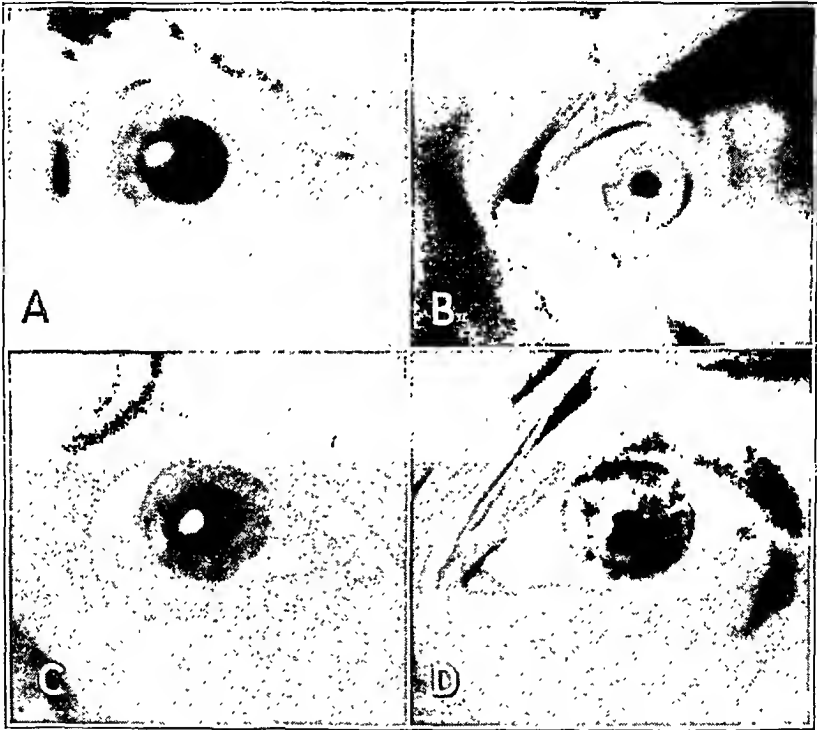
The second step in the technic is carried out under the same careful aseptic and anesthetic conditions as the first. Akinesis and retrobulbar injection are unnecessary but may be utilized for exceedingly unruly patients. The same type of dual illumination is used as previously described for the first step. With the lid speculum in place, the eyeball is fixed with a suitable forceps and a keratome incision, from 4 to 5 mm. in length, under a narrow conjunctival flap is made at the limbus on the temporal side. The temporal side is selected as the most convenient position where there is no anatomic structure to interfere with the insertion and manipulation of the suction end piece. The suction cannula, which is connected to a piece of rubber tubing and a mouth piece, is then introduced into the anterior chamber through the keratome incision, and by the application of oral suction the softened and partially liquefied lens débris and aqueous are aspirated into the tube. Usually there is some pupillary constriction as the lens is aspirated. Often it is necessary to maneuver the opening in the suction tip into an oblique position under the pupillary margin of the iris in order to facilitate aspiration and yet not injure the iris. Care must be taken not to tear the posterior capsule during aspiration. When the softened lens material has been removed, the suction tip is withdrawn, and the anterior chamber is permitted to refill with aqueous. When there is considerable atrophy of the iris and ciliary body, the reformation of the anterior chamber is naturally slow and may be hastened by injecting physiologic solution of sodium chloride through the keratome incision under the conjunctival flap. Care must be taken not to inject the solution under any appreciable pressure.

Next the eye is examined carefully under the ultraviolet rays. Fragments of lens débris that have escaped aspiration are immediately discovered, and their locations are noted. The posterior capsule appears as a fine whitish weblike structure under the ultraviolet radiation. Under general illumination, a second sterile suction tip is introduced into the anterior chamber, and with the aid of the ultraviolet ray lamp any remaining fragments of lens material are aspirated and the suction tip is withdrawn.

The anterior chamber is then permitted to reform again, and the third and final step in the procedure may be carried out as a continuation of the second step. A curved discission knife is introduced into the anterior chamber through the keratome incision, and a single linear vertical incision is made in the posterior capsule directly through the center of the pupillary area. This discission may be performed under the ultraviolet ray lamp, so that there need be no question as to the length and position of the opening of the capsule by the incision. A sterile syringe filled with air and fitted with a blunt-tipped lacrimal needle is now used to distend the anterior chamber with air. If the iris shows any tendency to

prolapse, it is replaced with an iris repositor. The use of air in the anterior chamber in no way interferes with healing. The air is gradually absorbed in from three to five days, during which time it holds the iris away from the cornea and prevents peripheral anterior synechiae.

Incidentally, it is surprising to many to find how well the eye tolerates air. I have used injections of from 2 to 3 cc. of air, as advocated by Arruga, directly into the vitreous cavity in several cases in which the eye became extremely soft after escape of subretinal fluid in operations for retinal detachment. When there is no retinal tear in the upper quadrants of the globe, where the air collects by gravity into a single bubble, this procedure is entirely harmless, and the air is gradually absorbed and replaced by tissue fluids. The procedure may be repeated with impunity if a subsequent operation for retinal detachment becomes necessary.



Aphakic eyes after removal of cataracts by aspiration technic. A, the eye in case 24; B, that in case 25; C, that in case 27, and D, that in case 26.

In completing the aspiration operation, usually no sutures are necessary, but if there is any gaping of the wound it is well to use a single black silk conjunctival suture. An ointment containing mercury bichloride in a concentration of 1:3,000 is instilled into the conjunctival sac, and both eyes are bandaged.

In some cases in which the patient becomes restless, in which there is hemorrhage from the wound or in which the pupil becomes markedly constricted after aspiration, the discission of the posterior capsule is not done until later, after the keratome incision has healed. In such instances the discission constitutes a separate third step in the technic.

The visual results are indicated in the table. It is interesting to note, especially in cases of congenital cataract, how vision improves with use of the eye for some time after the cataract has been removed.

SUMMARY AND CONCLUSIONS

On the practical basis of visual results, the aspiration method of cataract removal may be regarded as eminently successful. By this technic prolonged phacoanaphylactic reactions are avoided and the incidence of late postoperative complications is reduced to a minimum. It is a conservative procedure, involving only a small incision, which heals quickly, thereby limiting the dangers of hemorrhage and infection.

The technic is particularly suitable for children and for adults who are difficult to keep under quiet control. A surgeon may carry the operative work to almost any stage of completion, and if unfavorable circumstances intervene he may postpone the remaining surgical treatment until later, when circumstances become more favorable. On the other hand, the absolute quiet which is so necessary after a large corneal incision has been made is not such an important factor in the postoperative care after the use of the aspiration technic. Patients may be permitted considerable latitude in movement immediately after the aspiration operation and are permitted to be up much earlier than if some technic requiring a larger incision were used. The results obtainable by its use in carefully selected cases justify a prominent place for the aspiration technic among the conservative methods of cataract extraction.

2707 Book Tower.

SIR HANS SLOANE'S ACCOUNT OF AN EFFICACIOUS MEDICINE FOR SORENESS OF THE EYES

AN EPISODE IN EIGHTEENTH CENTURY OPHTHALMOLOGY

BURTON CHANCE, M.D.

PHILADELPHIA

Ophthalmic medicine in England in the first half of the eighteenth century was at low level. Quacks were in their heyday; Read, Grant, Taylor and other mountebanks flourished, but it was the final season of their harvesting. Surgeons like Cheselden, Sharp, Ware and others, strengthened by Daviel's success in the complete removal of cataract, began to arouse the interest of serious, honorable members of the medical profession in a scientific investigation and comprehensive understanding of the conditions affecting the eyes which they had for so long committed to the far from tender ministrations of irregular practitioners who were spoken of as "oculists" and regarded with the greatest scorn and contempt by the members of the regular medical profession. All sorts of nostrums were exploited, and society tolerated quackery from force of the example set by certain eminent physicians of the day who vended medicines the composition of which they kept secret. The great Dr. Mead possessed a secret powder (his favorite nostrum) which he sold for the bite of a mad dog.

Some time ago, while searching the index of *The Gentleman's Magazine* for 1771 for a reference on a general subject, I was astonished to see "Reflections on the Treatment of Ophthalmia."¹ Immediately abandoning my search and turning to the designated chapter, I found the article the title of which had attracted my attention. It was a rather lengthy letter from one who signed himself "Investigator," in which he criticized a method of treatment offered by that distinguished medical practitioner Sir Hans Sloane. Becoming absorbed in the contemplation of this letter, which vividly expressed a mode of therapy for active inflammation of the eye by practitioners in Western Europe two hundred years ago, I decided to make it the subject of an

Read before the College of Physicians of Philadelphia, Section on Ophthalmology, Dec. 16, 1937.

1. Reflections on the Treatment of Ophthalmia, *Gentleman's Mag. & Hist. Chron.* 41:485, 1771.

account of some of the ways diseases of the eyes were treated just before the dawn of the scientific understanding of the principles of ophthalmology.

To have found so specific a medical communication in a popular magazine was most unexpected. The magazine, however, should be of interest, the formal title being *The Gentleman's Magazine and Historical Chronical—Prodessi et Delectare—E Pluribus Unum*—by *Sylvanus*

T H E

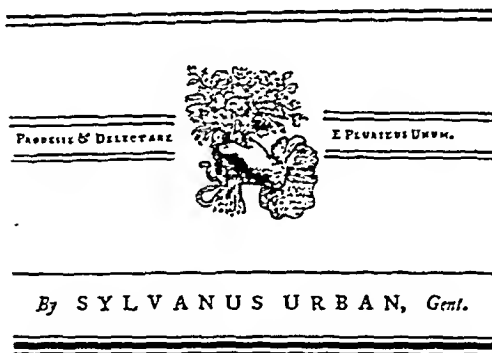
Gentleman's Magazine,

A N D

Historical Chronicle.

VOLUME XLI.

For the YEAR M.DCCLXXI.



L O N D O N :

Printed at St. John's Gate, for D. HENRY, and sold by F. NEWBERRY,
the Corner of St. Paul's Church-Yard, Ludgate Street.

Fig. 1.—Title page of *The Gentleman's Magazine and Historical Chronicle*.

Urban Gent—London. Antedating the popular “quarterlies,” *The Gentleman's Magazine*, issued monthly from 1730, published material gathered from many sources. At that time there were few medical journals published in English. Up to the opening of the nineteenth century means for the dissemination of medical knowledge were few and narrow in their scope. Authors wrote books and pamphlets, and the Philosophical Society received communications, to be published more or less fully in the transactions of the society.

After perusing the letter, I sought for Sloane's original publication and was rewarded by finding it in the library at the College of Physicians. I shall endeavor to describe it and to incorporate what "Investigator" had to offer in criticism of its provisions. It is a small pamphlet, of 17 pages; the title page is reproduced in figure 3.

The Gentleman's Magazine:

St. JOHN'S Gate.

London Gazette
Daily Advertiser
Public Advertiser
Public Ledger
Gazetteer
St James's Chron.
London Chron.
General Evening
Whitehall Even.
London Evening
Lloyd's Evening
Monday, Wednesday, Friday.
Oxford
Cambridge
Reading
Northampton
Birmingham 2
Bath 2 papers
Coventry 2
Bristol 3



York 2 paper
Dublin 2
Newcastle 2
Leeds 2
Edinburgh
Aberdeen
Glasgow
Ipswich
Norwich
Exeter
Gloucester
Salisbury
Liverpool
Sherborn
Worcester
Stamford
Nottingham
Chester
Manchester
Canterbury
Chelmsford

For NOVEMBER, 1771.

CONTAINING.

More in Quantity and greater Variety than any Book of the Kind and Price.

<p>Foreign Affairs.—Particulars of the seizure and deliverance of the King of Poland 478 —Outrages at Moscow, on account of an epidemic distemper there 478 Debates in a Newly established Society 479 —L. B.—'s motion for augmenting the army 48 —Gen. C.—'s motion for repairing the Garri- sons, &c. 48 —Mr. O.—'s motion for clearing the H. 48 —Mr. D.—'s motion for examining the Jour- nals of the House of Lords 48 —Mr. S.—'s motion that the Committee might not proceed on the Land-tax for 1771 48 K. Charles I not the Author of the <i>Excuse</i> 48 <i>Essays</i> Reflections on the treatment of Ophthalmia 48 An Entomologist's answer to Eusebia 48 Address to the Commissioners of Yarmouth Haven 48 Translation of Mr. Huet's Journey to Stock- holm 48 Second Vindict of Mr. Emerson's Astron. 49 Crit. Remarks on some passages of Voltaire 49 Account of the Lithopagus of Avignon 49 Curious Antiquities in Scotland described 49</p>	<p>Address to the Author of Remarks on Volt. 496 Dr. Percival on ulcerated Sore Throats 497 New Versions of the Ld's. Pr. with Rem. 499 On the progress of Vegetation in Trees 500 Artifice of the Thong exploded 500 On Dr. Hewson's enquiry into the properties of the blood 501 On the mistakes of eminent Authors 503 Quest. relative to the formation of mould 504 Meteorological Diary of the West 505 Review of Books.—The Complete English Farmer 505 —A Journal of a Voyage Round the World in his Majesty's Ship the Endeavour 509 —History and Memoirs of the Society formed at Amsterdam in favour of persons supposed to be drowned 512 Catalogue of New Publications 514 POETICAL ESSAYS.—Verses left in a Coffee house at Cambridge—Ode to Sleep—Alonzo —On the death of Miss Burton 515 —The Rash Wife—Translation of Hor. Ode xiii.—A sentimental Thought 516 HISTORICAL CHRONICLE.—List of Births, Marriages, Deaths, Preferments, &c.</p>
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Embellished with a Plan of the River SALWARK, and of the NAVIGABLE CANAL, from Droitwich, to the River Severn, in Worcestershire.

By S T L V A N U S U R B A N, Gent.

LONDON, Printed for D. HENRY, at St. JOHN'S GATE.

Fig. 2.—Table of contents of the issue of *The Gentleman's Magazine and Historical Chronicle* in which "Reflections on the Treatment of Ophthalmia" appeared.

Although I had known of Sir Hans Sloane's exalted position in medical and philosophic life in Europe in his century, until I saw "Investigator's" serious criticism I was not aware that he had been interested in any phase of ophthalmology. How came he in a position

to publish with authority a work in ophthalmology for which he has been given flattering notices in works of reference? In 1745 Sir Hans Sloane, physician to King George II, did publish "An Account of a Most Efficacious Medicine for Soreness, Weakness and Several other Distempers of the Eyes," basing the account on "the surprisingly beneficial effect of the use in my hands on a large number of patients" of a remedy which he ordered should be made in the following manner:

AN
ACCOUNT

OF A MOST

Efficacious Medicine

FOR

SORENESS, WEAKNESS,

And SEVERAL OTHER

DISTEMPERS of the EYES.

BY

Sir HANS SLOANE, Bart.

Physician to his Majesty, &c.



L O N D O N :

Printed for DAN. BROWNE, at the *Black-Swan*,
without *Temple-Bar*. MDCCLXV.

Fig. 3.—Title page of Sir Hans Sloane's book.

Take of prepared Tutty, one Ounce; of *Lapis Hæmatites* prepared, two Scruples; of the best Aloes prepared, twelve Grains; of prepared Pearl, four Grains. Put them into a Porphyry, or Marble Mortar, and rub them with a Pestle of the same Stone very carefully, with a sufficient Quantity of Viper's Grease, or Fat, to make *A Liniment*; to be used daily, Morning or Evening, or both, according to the Conveniency of the Patient. . . .

This account of his most "Efficient Medicine for the Cure of Sore and *Weak Eyes*" was made public for the "Benefit of Mankind; and

most humbly Dedicated to his MAJESTY." In the introduction, Sloane stated:

. . . having been led by a strong natural Inclination to the Practice of Physic, through an earnest Desire to be useful in my Profession, I was always very attentive to Matters of Fact, and the real Cures that fell under my Observation. Of these, I saw many performed upon *Sore Eyes* by Doctor *Luke* Rugeley; whereupon I applied to a very understanding Apothecary of his particular Acquaintance and mine, and endeavoured, though without Effect, to procure some Knowledge of the Medicine he made use of. After the Doctor's Death, I still pursued my Enquiry, by searching into his printed Books, and Manuscript Papers, and particularly into a very curious *Materia Medica* left by Him; but all in vain; 'till at length a Person, whom I believe he had employed in making his Medicine, came to me; and for a pecuniary Reward, joined to a Promise of not divulging it to his Prejudice, delivered me up the genuine Receipt, in the Doctor's own Hand-Writing; which, as I reformed, improved, and used it many Years, is as follows [composed of the ingredients already quoted].

This Medicine I soon tried, and, though a Composition, found it so surprisingly beneficial, that by the right Use of it not one in five Hundred missed of a Cure; unless their Disorder proceeded from a Venereal Taint.

"Investigator" was skeptical of Sloane's statement of his results and declared it to be "most certainly necessary to examine supposed facts before we admit their validity." The object of his letter was "to candidly enquire into the effects of the remedy recommended for an Inflammation of the eye, under the sanction of that great man." "Investigator" believed that "in few cases can the wrong application of topical remedies be productive of more lamentable prejudice than to the organ of vision," for this reason, he concluded, "I therefore should be excused." And he stated further, because "humanity was Sloane's motive for publishing it, humanity is my motive solely for considering it at that time when numbers were laboring under the complaints for which this medicine was said by Dr. Sloane himself, to be 'so surprisingly beneficial.'"

"Investigator's" experience with this liniment was disappointing. "In general," he stated, "when I have tried it, so much injury has been sustained, that I have been thereby lead to examine more particularly, the several ingredients of which it is composed." He learned that "tutty contains an argillaceous earth, probably with some proportion of the semi-metal called zinc, and a small quantity of lead. The last appears to have a sedative effect and in that view may be admissible; how far the zinc and the argillaceous basis of Tutty might prove hurtful cannot be wholly ascertained. *Lapis Hæmatites* is a rich iron ore, and must without doubt, prove highly stimulating, increase the inflammation, and thereby produce the most alarming effects. *Aloes* internally is stimulating, and by its effects when applied to ulcers, it is probable that it possesses the same quality when used topically in Inflammation of the

Eye. Pearl, Prepared, is ordered in so small a proportion, that little or no effect can be expected from it; it may, perhaps, act as a mechanical stimulus to the tender coats of the eye. If the *Viper's grease* be not rancid, like oil, it may relax, and thereby prove useful; but most of the other ingredients are evidently calculated to increase inflammation and pain and are therefore inadmissible."

I too, sought, to learn of what the remedy was composed. In modern terms, "tutty" is crude zinc oxide, a brownish, powdery substance obtained from the flues of smelting furnaces. It was known in the Middle Ages and was used by the Arabians, as references can be found in the earliest Arabian works on ophthalmology.

[2]

cary of his particular Acquaintance and mine, and endeavoured, though without Effect, to procure some Knowledge of the Medicine he made use of. After the Doctor's Death I still pursued my Enquiry, by searching into his printed Books, and Manuscript Papers, and particularly into a very curious *Materia Medica* left by Him: but all in vain; 'till at length a Person, whom I believe he had employed in making his Medicine, came to me; and for a pecuniary Reward, joined to a Promise of not divulging it to his Prejudice, delivered me up the genuine Receipt, in the Doctor's own Hand-Writing; which, as I reformed, improved, and used it many Years, is as follows.

The

[3]

THE RECEIPT.

TAKE of prepared Tutty, one Ounce; of *Lapis Hæmatites* prepared, two Scruples; of the best Aloes prepared, twelve Grains; of prepared Pearl, four Grains. Put them into a Porphyry, or Marble Mortar, and rub them with a Pestle of the same Stone very carefully, with a sufficient Quantity of Viper's Grease, or Fat, to make a *Lini-ment*; to be used daily, Morning or Evening, or both, according to the Conveniency of the Patient: as hereafter directed.

This

Fig. 4.—Introductory pages of Sir Hans Sloane's book.

Alas for Sloane's vaunted primacy! "Several Years after I had been in Possession of this Secret," he tells us, "in turning over some Manuscripts of Sir *Theodore Mayerne*, I found Mayerne had known the same Ointment, or Liniment, and had entered it in his *Pharmacopœa*, under his own Name: though I afterwards discovered, that it was not originally his, but had been communicated to him by Sir *Matthew Lister*, a Member of the College of Physicians; who had performed a Cure with it on a Lady *Savile*, which Sir *Theodore* thought a very extraor-

dinary one. And 'tis very probable, that he afterward communicated it to Dr. *Thomas Rugeley*; as I found they were Contemporaries, and Friends.

"The Method, which best succeeded with me in facilitating the efficacious Use of this Liniment, is to bleed, and blister in the Neck and behind the Ears, in order to draw off the Humors from the Eyes; and afterwards, according to the Degree of the Inflammation, or Acrimony of the Juices, to make a Drain by Issues between the Shoulders, or a perpetual Blister."

"Investigator" maintained "unless we make blisters perpetual, an Ophthalmia of long standing is seldom much relieved by them. The first or serous discharge of a blister, and the matured pus of an issue appear to have different effects. The latter I have found much more beneficial, but in the manner Sir Hans Sloane directs, between the shoulders, it is extremely troublesome; and I have therefore tried it behind the ear, just below the *processus mammillaris*. We have there a fleshy part as suitable as if designed by nature for such a purpose. It is about that part that nature forms frequently a drain in young children, the utility of which is known to every practitioner in medicine.

"The easiest manner of making an issue here, is by means of a caustic, the *causticum commune fortius* of the London Dispensatory. When the eschar produced by it is digested out, a pea, or half of one, may be introduced, and the part dressed in the usual manner." For washing the eyes, Sloane "generally recommended Spring Water; which he thought preferable to any spirituous Lotion, whether simple or compound."

"Investigator" hesitated to enumerate remedies for external application to the eye. He had known pain to be mitigated by a lotion made of the decoction of poppies. Spring water, solutions of vitriol, alum, sugar of lead and the vegetable solution of M. Gouillard had likewise relieved pain; he had also used poultices of bread, roasted apple, curd of milk, conserve of roses and various preparations of *lapis calaminaris*, and "tutty." But for an obstinate ophthalmia, the best of them proved ineffectual. "And the best inward Medicines," Sloane stated, "I have experienced to be Conserve of Rosemary Flowers; Antiepileptic Powders, such as *Pulvis ad Guttetam*; Betony, Sage, Rosemary, Eye-bright, Wild Valerian Root, Castor, washed down with a Tea made of some of the same Ingredients; as also Drops of *Spirit Lavendulae composit* and *Sal volat oleos*.

"If the Inflammation returns, drawing about six Ounces of Blood from the Temples by Leeches, or Cupping on the Shoulders, is very proper. The Liniment is to be applied with a small Hair Pencil, the Eye winking or a little opened."

"Investigator," commenting on these directions, pointed out that Dr. Sloane resorted to other well known effectual remedies in an ophthalmia. He himself was cautious in applying leeches to the temples, as he had found it difficult to stop the blood and to prevent the cold so liable to develop in the patient from the application of wet cloths to take up the blood, and that this method was not convenient and frequently increased the inflammation. He therefore substituted cupping, without any of the inconvenience, which could be repeated as occasion required.

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Castor, &c. walked down with a Tea made of some of the same Ingredients: as also Drops of *Spirit. Lavendulae composit.* and *Salvolat. oleos.*

If the Inflammation returns, drawing about six Ounces of Blood from the Temples by Leaches, or Cupping on the Shoulders, is very proper.

The Liniment is to be applied with a small Hair Pencil, the Eye winking or a little opened.

In prosecuting the Cure of sore Eyes, I have been sometimes surprized by want of Success; 'till at length I found, that the Cause was a lurking intermitting Fever, every Fit of which affected the Eyes, and rendered their Disorder obstinate: wherefore upon taking off the Fever by a proper Use

[7]

Use of the Bark, the Cure has been effectually performed.

This Medicine has cured many, whose Eyes were covered with opaque *Films*, and *Cicatrices* left by Inflammations and Apostems of the *Cornea*; which, though they happen to Persons of all Conditions, yet are more common among the poorer Sort of People: many of whom were so totally deprived of Sight, as to be under a Necessity of being led to me; and after some time could perfectly well find their Way without a Guide, to my great Satisfaction. And it is not only very beneficial in such Cases, but also where there is an excessive Pain in the Eyes, shooting thence up into the Head: as I particularly remember in a great Lady, who had such Pains in her sore Eyes, and Head, that she had, when I first saw her,

Fig. 5.—Pages on therapy in Sir Hans Sloane's book.

Sloane was "sometimes surprized by want of Success; 'till at length I found, that the Cause was a lurking intermittent Fever, every Fit of which affected the Eyes, and rendered their Disorder obstinate: wherefore upon taking off the Fever by a proper Use of the Bark, the Cure was effectually performed.

"This Medicine has cured many, whose Eyes were covered with opaque *Films*, and *Cicatrices* left by Inflammations and Apostems of the *Cornea*;—common among the poorer sort of People: many of whom were so totally deprived of Sight, as to be under a Necessity of being led to me; and after some time could perfectly well find their Way without a Guide, to my great Satisfaction."

Alas! In such cases as these "Investigator" noted that "the mechanical attrition of the ingredients against such films may be useful, but these complaints are widely different from Ophthalmia. I have frequently known powdered glass blown into the eye, of the greatest benefit in such diseases, but no prudent man would recommend the same remedy in a painful inflammation of that organ."

"It is not only very beneficial in such Cases," Sloane continued, "but also where there is an excessive Pain in the Eyes, shooting thence up into the Head: as I particularly remember in a great Lady, who had such pains in her sore Eyes, and Head, that she had, when I first saw her, taken about fifty Drops of *Laudamum* thrice in twenty-four Hours, of which Complaints she and many others had been relieved by this Medicine, without the help of any Opiate."

In "Investigator's" practice, "when the pain accompanying an Ophthalmia comes on periodically, with some degree of fever, bark is given internally with great advantage."

Sloane cited the case of a commissioner, who brought commendatory letters from friends in France, in whose eyes he observed "a great Soreness and Weakness, of which the Application of my Medicine very soon cured him. Whereupon Monsieur *Anisson* assured me, that he would procure me from the King his Master any Reward I should think fit to ask for the Secret; the King being accustomed to oblige his Subjects that way." "But," stated Sloan, "I answered him that I was then bound by a Promise to conceal it."

Incidentally, Sloane observed, "Cathartics, especially with the Addition of Mercury, are prejudicial in the Diseases of the Eyes, which are cured by this Medicine."

But "Investigator" stated, "In obstinate inflammations, I have sometimes seen mercurials of service, particularly Van Sweeten's sublimate solution. No hesitation can be made to giving this medicine very early in this complaint, especially where either any scrophulous or venereal taint is suspected."

Sloane continued, "It is also worthy of Remark, that People afflicted with weak Eyes are over-fond of Hoodwinking, or covering them from the Light; which sometimes retards the Cure, by keeping their Eyes too warm: and therefore I have constantly advised them to throw away these Coverings, as soon as they could possibly bear the Light." "Investigator," on the contrary, usually found it necessary to adjust "a slight piece of silk to prevent the too powerful rays of light, and the cold air, from affecting the inflamed eye."

Sloane's knowledge of the "great Virtue of *Viper's Grease or Fat*, in the Cure of Diseases of the Eyes" was acquired from several sources. He was intimately acquainted with "*William Stokeham*, a very ingenious

Gentleman Physician to King *William III* who had formerly spent some years at *Padua*, acquainted with the most eminent Physicians of that University," the first to tell him of it; it is recommended for that Purpose by *Daniel Ludovicus*, in his Book *De pharmacia moderno seculo applicando*, Gothae, 1671, 12°."

In the original receipt, hog's lard was named, but Sloane substituted "the Grease or Fat and found, that it added so much to the Efficacy of the Medicine, as to make it do, what I thought, Wonders, And as I was not bound to Secrecy, with regard to this Improvement, I communicated it to the late Dr. *Arbuthnot*: who, after repeated Trials of that Fat alone on sore Eyes, had so high an Opinion of its Virtues, that he looked on it as equally beneficial with the whole Medicine."

Sloane had "read in some *Missionary Letters*, that Serpent's Fat is used by the *East Indians*, for the same Purpose." He stated, "It is an Observation made by many Naturalists, that those Serpents cast their skins every Year, and with them the Coverings of their Eyes: but how far, or whether at all, their Fat is concerned in this *Phenomenon*, I leave to others to determine."

To this experience of Dr. Arbuthnot "Investigator" heartily subscribed, and he believed that "the addition of the other ingredients to Viper's fat only rendered the liniment stimulating and dangerous in a real Ophthalmia."

Sir Hans continued, "One of the most eminent and learned Chirurgical Authors, to whom I had a particular Regard in my Practice, cautions his Readers against the Use of Oil in Diseases of the Eyes; by which, I suppose he meant Olive-Oil." Here follows a most naive remark: "Agreeable to this Caution, I confess, I have never used any Oil, either alone, or mixed with other Medicines, for the Eyes; being unwilling to try Remedies, whose Effects were doubtful, and may possibly be pernicious: which I afterwards observed to be the Case with regard to Olive-Oil, when used by some People (to whom I had given the Liniment) in order to make it more liquid, upon drying; for the Liniment, in that State, has caused very considerable Complaints. This, in my Opinion, proceeds from some hot, sharp Particles, contained in the Oil; though it is generally reckoned very soft and mild in outward and inward Use: for I remember, when at *Montpellier*, I was informed by Monsieur *Magnol*, and others of my Acquaintance there, that the feeding of tame Rabbits with Olive Leaves, in want of other Food, has caused their making bloody Urine."

Sloane added, "I had formerly, as already said, promised Secrecy with regard to this Medicine: which I have religiously kept 'till now, that I think myself, for many Reasons, abundantly absolved. I have had some other Medicines of the like Nature communicated to me under the same Restriction: and exclusive of these few Cases, I cannot charge

myself with making the least Mystery of my Practice. For in Consultations, in a Number of Cases of Importance, I have been always very free, and open; far from following the Example of some Physicians of good Morals and great Reputation, who have on many Occasions thought proper to conceal Part of their own acquired Knowledge alledging the Maxim: *Artis est celare Artem*. And that I have not been inclined to conceal or monopolize Medicines of great Use, the following Instance will sufficiently show."

Sloane ends this small book by recounting the tale of a secret medicine in the possession of a certain family with which "they infallibly cured all Men and Beasts, bit by Mad Dogs and other Creatures." As this was a "Matter of Great Consequence to the Public," Sloane sought for an account of it, which he states he published in the *Philosophical Transactions* No 237. It seems that the receipt called for an ingredient well known to be a "pernicious vegetable," which was mistaken "for some other harmless plant, and notified botanists of the error and recommended to them to provide a Quantity of the *Lichen*, sufficient to answer all Occasions." He added, "It was accordingly made use of with the same Success, with which it has ever since been attended."

This pamphlet was the only separate medical work published by Sloane. A second edition was published in London in 1750 and one in French, "*Histoire d'un remède très efficace pour la foiblesse et rougeur des yeux*," in Paris in 1746.

The College of Physicians possesses another edition in French, by M. Cantwell, a member of the Royal Society of London. It was published in Amsterdam by Arkstee and Merkus in 1767 and contains copious notes describing and endorsing Sloane's therapeutics. This edition is bound with a serious work by Saint Yves.

It is extraordinary that this pamphlet was for so many years held in great estimation and was republished. There is not a line concerning pathologic descriptions or the slightest inkling as to the symptoms which Sloane diagnosed as "ophthalmia."

That so famous a man as Sir Hans stooped to purchase a secret remedy, the ingredients of which he never sought to analyze, for use in as delicate an organ as the human eye is a sad commentary on the state of practice. That he, the companion of the highest-placed scientists of his day and himself capable of serious study and research in certain of the physical sciences and natural history, should have had so little regard for the conservation of his fellow men as to prescribe his "tutty compound" for hundreds of afflicted persons is one of the sad notes in that benighted era.

By this time one may rightly ask, "And who was the author of this singular treatise?" Every one knows that Sir Hans Sloane was one

of the notable physicians of the seventeenth and eighteenth centuries, but he has not been generally classed with those who became distinguished as ophthalmologists. The only separately published medical work which I have yet been able to find is this one on the eyes, a truly singular document which might be accepted as one of the landmarks in the history of English ophthalmology. This work must have been accepted by practitioners on the authority of its distinguished author, whose position in the scientific and social circles in England was

HISTOIRE
D'UN REMÈDE
TRE'S EFFICACE
 POUR LA FOIBLESSE ET ROUGEUR.
DES YEUX,
ET AUTRES MALADIES DU MEME ORGANE.
 Avec un Remède infallible contre la morsure
 du chien enragé.

Par le Chevalier HANS SLOANE, Baronnet,
 Médecin du Roi d'Angleterre & ancien
 Président de la Société Royale & du
 Collège des Médecins de Londres.

Traduits de l'Anglois & enrichis de notes par M.
CANTWEL, Docteur Régent de la Faculté
de Médecine de Paris, & Membre
de la Société Royale de Londres.



A AMSTERDAM ET A LEIPZIK,
 Chez ARKSTÉE & MERKUS,

M. DCC. LXVII

Fig. 6.—Title page of the French edition of the book by Sir Hans Sloane.

unquestioned for over fifty years. The first remonstrance I have found was that of "Investigator" in *The Gentleman's Magazine*.

Sloane was born in Ireland in 1660, of an English mother and a Scotch father. The precocious lad early devoted himself to natural history, until, when about 16 years of age, he was seized with hemoptysis. Recurrent attacks until his ninetieth year caused him to cease all studies for three years. In 1679, arriving in London, already a well read student, he seriously resumed his researches in botany and the physical

sciences, immediately attracting to himself the foremost men of his day, who encouraged and advanced him in his favorite studies. In a year or so he went to France to pursue his investigations, and while there was induced to enter the practice of medicine. On his return to England he became associated with Sydenham, in whose house he resided for a time and through whose support he soon obtained a footing in London as a physician.



Fig. 7.—Sir Hans Sloane.

In 1685, already a fellow of the Royal Society, he sailed to Jamaica in the capacity of personal physician to the newly appointed governor of that island. The voyage from England offered much to the young man, for he visited all the islands in the Caribbean Sea. The governor died a few months after reaching Jamaica, but Sloane remained on the island to collect plants and study the indigenous animals. He applied himself assiduously to his collecting and on the return voyage classified his 800 specimens and outlined a "Natural History of Jamaica," which

he afterward published, the first volume appearing in 1707 and the second in 1725.

Appointments and honors came fast. He became associated with nearly all the hospitals, serving them faithfully and contributing to their funds. He was president of the College of Physicians; secretary of the Royal Society, and, on the death of Sir Isaac Newton, president of the society. King George II created him baronet, the first physician to be so knighted, and, besides serving as physician general of the army, in 1727 he was appointed physician to the king.

His constitution was always delicate, yet he survived all attacks of disease and lived to the great age of 92, dying at Chelsea in January 1753. All his life he had been a collector. His house in Bloomsbury became a crowded museum. When about 50 years of age he purchased the Apothecaries' Gardens at Chelsea, where he later removed his collections and took up his residence. He deeded the gardens to the Apothecaries' Society, with the understanding that they should be maintained. And so they are to this day, devoted to the promotion of botanic knowledge and especially to the cultivation of curious and rare plants.

At his death his museum and library of 50,000 volumes and 3,500 manuscripts were purchased by the nation for 20,000 pounds. This was the commencement of the British Museum.

He contributed numerous reports to the *Philosophical Transactions*, but his greatest work was the "Natural History of Jamaica."

Sloane should be honored for advocating and using the Jesuits' cinchona bark and for giving inoculations in his efforts to combat small-pox.

The wayfarer in London is reminded of him, as his name has been perpetuated in streets, squares and crescents and even by a telephone exchange!

ENCEPHALITIC OPTIC NEURITIS AND ATROPHY DUE TO MUMPS

REPORT OF A CASE

CHARLES M. SWAB, M.D.

OMAHA, NEB.

As the field of practice in a specialty is naturally more or less restricted, there are a variety of aspects of certain diseases and their complications which rarely come under observation. This statement of fact is particularly true of the specialties that have to do with the consequences of mumps. By way of introduction, a brief summary of the general subject may serve the twofold purpose of furnishing a background for the case to be reported and presenting data that are not regularly observed and noted in routine work. To delve even cursorily into the published material on epidemic parotitis brings conclusive evidence that little of consequence has been added to the general subject by present day observers, as the field has been thoroughly investigated and the various findings recorded. It is, in itself, not a new topic, as the disease was well known even in the time of Hippocrates. He alluded to the absence of suppuration in the parotid gland and also to the fact that orchitis sometimes followed parotitis. In all ages outbreaks of mumps have been both numerous and extensive, especially among soldiers in garrisons and among youths in institutions like the old-fashioned boarding schools. The usual age of incidence, however, is that of childhood, as children are gregarious and, owing to the nature of school contacts, the contagion is more likely to spread. That age does not insure immunity is evident from the fact that persons in the ninth decade have been afflicted.

Of chief interest here, however, is a consideration of the complications of mumps. Orchitis is so common and simple in its manifestations as to require little comment; oophoritis, however, though less frequent, may prove to be a far greater hazard to the patient. I recall a case in which oophoritis developed in a 4½ year old girl after mumps; peritonitis resulted and eventually death. Involvement of the central nervous system is not uncommon, but in such instances the chances of ultimate complete recovery are favorable. By way of exception to this general statement, I note and even stress the inflammations that attack the auditory and optic nerves.

Read at a joint meeting of the Omaha and Council Bluffs Ophthalmological and Oto-Laryngological Society and the Kansas City Society of Ophthalmology and Oto-Laryngology, Nov. 18, 1937, Omaha.

When disease of the central nervous system complicates the primary parotitis, either the meninges or the brain tissue may be the chief site of the inflammation; in some cases there is evidence of both meningitis and encephalitis. From a review of about 250 cases of parotitis with involvement of the nervous system, McKaig and Woltman¹ found encephalitis to be of rather frequent occurrence. Quadriplegia may be associated with paralysis of the cranial nerves, as in the case of a 7 year old child reported by Revilliod;² there were paralysis of both abducens nerves and of the left facial and the right hypoglossal nerve, in addition to paralysis of the extremities. The sixth cranial nerve is the most susceptible of those controlling ocular motility. With respect to the auditory nerve, Hubbard³ expressed the opinion that from 3 to 5 per cent of the deaf-mutism in the United States is due to mumps. The sudden onset of deafness is believed by some to follow an exudate occurring in the labyrinth. Pathologic examination of the inner ear has been recorded by Toynbee,⁴ who found complete disorganization of the neural apparatus in the labyrinth and a dark fluid in the vestibule and cochlea.

Many writers have presented in detail their observations in regard to the ocular complications of parotitis. Woodward⁵ published an extensive account of these data and drew attention to cases of dacryoadenitis, iritis, retrobulbar optic neuritis, night blindness, conjunctivitis, acute dacryocystitis and keratitis. Butler⁶ reported 2 cases of paralysis of accommodation with paralytic mydriasis, but added that there was complete recovery in both. Larkin⁷ gave a detailed report of a case of bilateral choked disk. Woodward⁵ also described the histologic changes in an eye that had been blinded by parotitic optic neuroretinitis three and one-half years before it was enucleated for secondary glaucoma and staphyloma. Section of the optic nerve showed complete atrophy, replacement with hyalin and obliteration of the small vessels of the nerve sheath.

REPORT OF CASE

On Jan. 18, 1937, I was consulted by M. J. L., a white man aged 25, referred to me by Dr. L. D. McGuire. The complaint at the time was loss of vision in

1. McKaig, C. B., and Woltman, H. W.: Neurologic Complications of Epidemic Parotitis: Report of a Case of Parotitic Myelitis, *Arch. Neurol. & Psychiat.* **31**:794 (April) 1934.

2. Revilliod, L.: *Rev. méd. de la Suisse Rom.* **16**:756, 1896.

3. Hubbard, T.: *Tr. Am. Otol. Soc.* **13**:451, 1915.

4. Toynbee, cited by Mauthner, O.: *Arch. f. Ohren-, Nasen- u. Kehlkopfh.* **87**:223, 1912.

5. Woodward, J. H.: *Ann. Ophth.* **16**:7, 1907.

6. Butler, T. H.: *Brit. M. J.* **1**:1095, 1930.

7. Larkin, W. R.: *Illinois M. J.* **38**:133, 1920.

each eye. Inquiry brought out the following history: On Nov. 28, 1936, while working in the south, the patient contracted bilateral parotitis. After he had remained in bed for several days, with the temperature reaching a maximum of from 102 to 103 F. almost daily, the right testicle became swollen and painful. The period of convalescence was uneventful until Jan. 4, 1937; on arising that morning the patient discovered that he could see only a blur of light with his right eye. Nine days later a similar condition occurred in the left eye. There was a deep-seated soreness behind the eyeballs; this had come on with the loss of vision, and persisted. Tonsillectomy and adenoidectomy were performed by a physician in Mississippi on January 6.

When the patient was first observed by me his visual acuity was reduced to faulty projection of light. The external ocular structures were normal except for widely dilated pupils, which were inactive to the usual stimuli. Study of the fundus of the right eye showed a swelling of the nerve head of 3.5 diopters. Although the retinal veins were markedly engorged, there were no exudates or hemorrhages in the retina. Examination of the fundus of the left eye showed similar changes, but with 1 diopter less of swelling of the optic disk.

Additional data were obtained by Dr. McGuire and Dr. A. E. Bennett, both at examinations in their office and during the period in which the patient was in the hospital, from January 20 to February 2. A general neurologic study revealed hyperactive tendon reflexes throughout. The first spinal puncture showed a range of pressure of from 10 to 12 mm. of mercury; subsequent punctures indicated a gradual lessening of pressure, although manometric readings were not made. There were 5 cells per cubic millimeter, and the protein content was twice normal. The Wassermann test was negative, and the colloidal gold curve was normal. The blood count showed 10,000 leukocytes; the stained blood smear was in the main normal. During the period of hospitalization, six treatments with artificial fever were given. This therapy was administered for a total of fifteen hours by means of the Kettering hypertherm at from 104 to 105 F. I saw the patient two days after his second treatment and observed a slight subsidence of the swelling of the disk in each eye. Vision in the right eye was considerably improved; the patient could see to get around unaided.

When he reported at my office on February 2, the vision in the right eye was 1/70; that in the left eye was 1/100. Projection of light was normal. At this time the disks exhibited marked atrophy, although the nasal border of the left disk still showed 1 diopter of elevation. The next and final observation of the patient was made on May 28. The vision in the right eye was 3/200, and in the left, 1.5/200. Each pupil measured 6 mm. and reacted sluggishly to light. There was typical postpapillitic atrophy of the nerve heads, and studies of the visual fields likewise gave typical results.

COMMENT

With respect to encephalitis that follows epidemic parotitis, practically nothing is known of the pathologic process. It is not known with certainty that the direct cause of mumps is either the direct or the sole cause of the neurologic phenomena. Nor may it be stated, except theoretically, that mumps activates a virus which is already existent in the central nervous system, thereby causing neurologic complications. In such a case, in the absence of infectious processes other than mumps, the encephalitis is naturally regarded as a complication of the primary disease.

From a review of the published accounts of cases of mumps in which there was ocular involvement, it appears obvious that the various treatments used have been regarded as of only slight, if any, real benefit. I have attempted to rationalize the treatments that seemed to warrant consideration in such cases. Theoretically, at least, any and all treatment should have as its objective a threefold purpose: first, the combating of toxins in the affected area; second, the maintenance of the nutrition of the involved nerve tissue, and third, the dehydration of the inflammatory zones without destruction.

Drainage of the spinal fluid has been recommended by Hubbard³ to aid in decompressing the involved nerve tissue. This measure is universally recognized and is regularly practiced in cases of encephalitis. Hyland⁸ inferred that the complications of mumps may be prevented by the use of convalescent serum. This prophylaxis is justified on the basis of acquired antibodies which combat the toxins of the disease. It may well be remembered, too, in this connection that human blood serum is a dehydrating agent. As such, it is amenable to control within certain limitations by the regulation of the dosage and by the interval between treatments. It can be seen from the case reported that fever therapy acted quickly in dehydrating the swollen optic nerves. In favor of this treatment, too, is the improved nutrition which should result from maintenance of the blood supply through the increased body temperature.

CONCLUSIONS

One cannot postulate in any case of encephalitis the improvement that may be anticipated by therapy any more than one can forecast the result that may follow the natural healing and compensatory phases of acute inflammations. Since it has won the favor of the medical profession at large, drainage of the spinal fluid stands and will have to stand on its merits as a therapeutic measure in cases of encephalitis following parotitis. Even though one accepts the premise that the antibodies of convalescent serum prevent the complications of mumps, there is no evidence to show that convalescent serum will aid in relieving established complications in the central nervous system. I mention this treatment merely as a clinical experiment of possible but unproved value. There is no denying the fact, however, that the fever therapy referred to in this case had a direct and beneficial effect on the patient.

8. Hyland, C. M.: *Nebraska M. J.* 22:342, 1937.

SIMPLIFICATION OF THE O'CONNOR CINCH OPERATION

M. E. SMUKLER, M.D.

PHILADELPHIA

The O'Connor cinch operation for tendon and muscle shortening, described in a recent textbook as "not so easy to perform," is greatly simplified and shortened with the new instruments and operative procedure described here. It is my operation of choice in all cases of divergent squint and in some properly selected cases of convergent squint of moderate degree.

The tendon and muscle are divided into three or four equal strands from the insertion back toward the equator, one, two or three loops of a cable (Dr. O'Connor's term is "shortener") composed of four, six or eight strands of medium dermal suture being used. The number of muscle divisions, loops and cable strands depend on the age of the patient, the degree of squint and the condition of the tendon and muscle found at the time of operation. Slight overcorrection in each eye is desirable. Care must be taken to avoid increased tension of the tendon, caused by having the loops too near the cornea. This may result in keratitis or sloughing of the muscle. I have never encountered these complications, but they have been observed (Zentmayer).

INSTRUMENTS

The following instruments are required:

1. Cables of four, six or eight strands of medium dermal suture, 12 inches (30 cm.) long (fig. 1). The ends of these strands for $1\frac{1}{4}$ inches (3 cm.) are joined with several layers of metallic X cement. This united flexible metallic end is easily bent, forming a curved needle and needle holder. It enables the cable to be slipped easily under and around the strands of the elevated and divided muscle, so that they may be looped as often as is necessary. The other end of the cable is held together with some of the cement, so as to facilitate handling. The idea of the cable was devised by Dr. O'Connor, who has sent me a cable with only one end fastened together, and that to the extent of but $\frac{1}{2}$ inch (1.3 cm.). However, the cable as constructed by me greatly simplifies the operative procedure.

Read before the Eye Section of the Philadelphia County Medical Society,
April 7, 1938.

2. A sharp-tipped curved hook. This is used to separate the tendon and muscle into strands of equal width (fig. 2 *A*).

3. A blunt-tipped curved hook (fig. 2 *B*). This facilitates handling the strands of tendon and muscle and in separating the strands of muscle.

4. A pair of large flat muscle hooks (fig. 3). These hold the tendon and muscle well spread out.

5. A pair of three and four strand separators (fig. 4). One separator placed at each end of the divided tendon and muscle separates the strands and slightly elevates them from the globe, facilitating looping the cable around the strands as often as desired.

OPERATIVE PROCEDURE

1. A semicircular conjunctival incision is made, well in front of the insertion and extending backward parallel slightly above and below the margins of the tendon.

2. The tendon and muscle from the insertion back toward the equator are exposed and isolated. It is important to avoid extended mutilations and unnecessary pocket dissections. The steps of the new operative procedure follow: The fascia surrounding the tendon and muscle to be included in the strands is gently cleaned. This procedure facilitates the division of the tendon and muscle into strands of equal size; the insertion and removal of the separator; the wrapping of cable loops around the strands, pushing the loops together, and the removal of the cable at the end of fourteen days. It also gives a good adhering surface and stirs up a certain amount of reaction, which causes better union during the process of repair.

3. The flat muscle hooks are inserted at each end to hold tendon and muscle well spread out, so that they can be divided into three or four equal strands; a sharp curved hook is then inserted beneath, a small longitudinal incision or nick being made to separate the fibers. With the blunt hook inserted into the separation, it is extended from the insertion backward toward the equator for a distance slightly greater than the amount of shortening desired. Great care should be taken to avoid cutting across any muscle fibers; they should merely be separated. If the tendon and muscle are to be divided into three equal parts, this is best accomplished by inserting the sharp curved hook beneath each margin. If the division is to be into four strands, the tendon and muscle are divided into half from beneath. Each half is then divided into two strands by passing the sharp curved hook beneath each half at the upper and the lower tendinomuscular margin.

4. After the tendon and muscle have been divided into strands, one muscle hook is removed and replaced by a separator, inserted like a

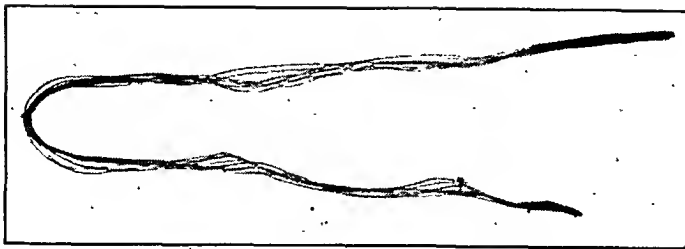


Fig. 1.—Cable of eight strands of medium dermal suture with metallic X cement at the ends.

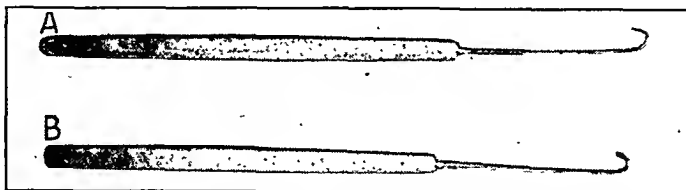


Fig. 2.—*A*, sharp-tipped curved hook to separate the muscle and tendon into strands of equal width. *B*, blunt-tipped curved hook to facilitate handling the strands of tendon and muscle. (One-half actual size.)

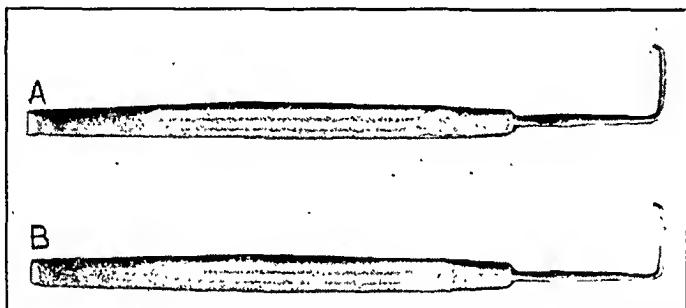


Fig. 3.—Pair of large flat muscle hooks, to hold tendon and muscle well spread out. (One-half actual size.)

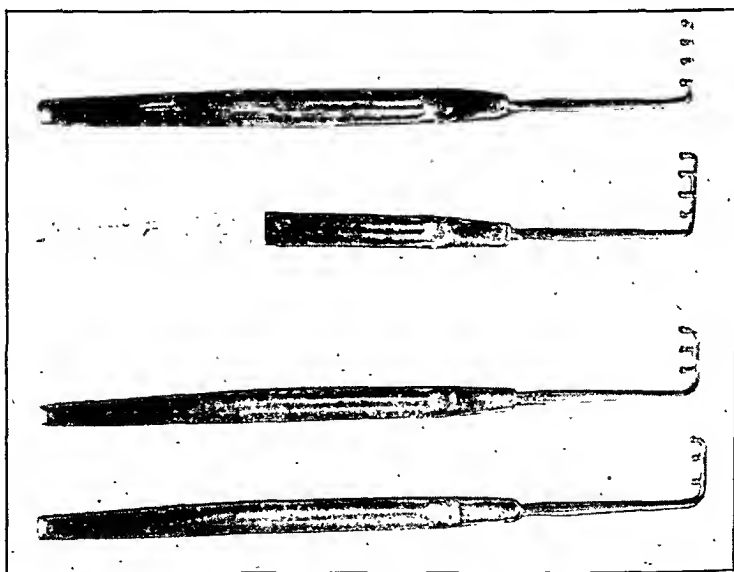


Fig. 4.—Pair of three and four strand separators. One at each end of the divided tendon and muscle separates the strands of tendon and muscle and slightly elevates them from the globe, facilitating looping the cable around the strands as often as possible.

muscle hook. Each strand will usually fall into a separate groove if the instrument is properly inserted and the tendon and muscle are properly prepared for its reception. If a strand does not fall in its proper place on the separator, it should be gently lifted with the blunt hook and properly placed. With the strands in place, the other muscle hook is removed and replaced by the other separator. This is inserted next to the first separator, so that the strands will be in their proper

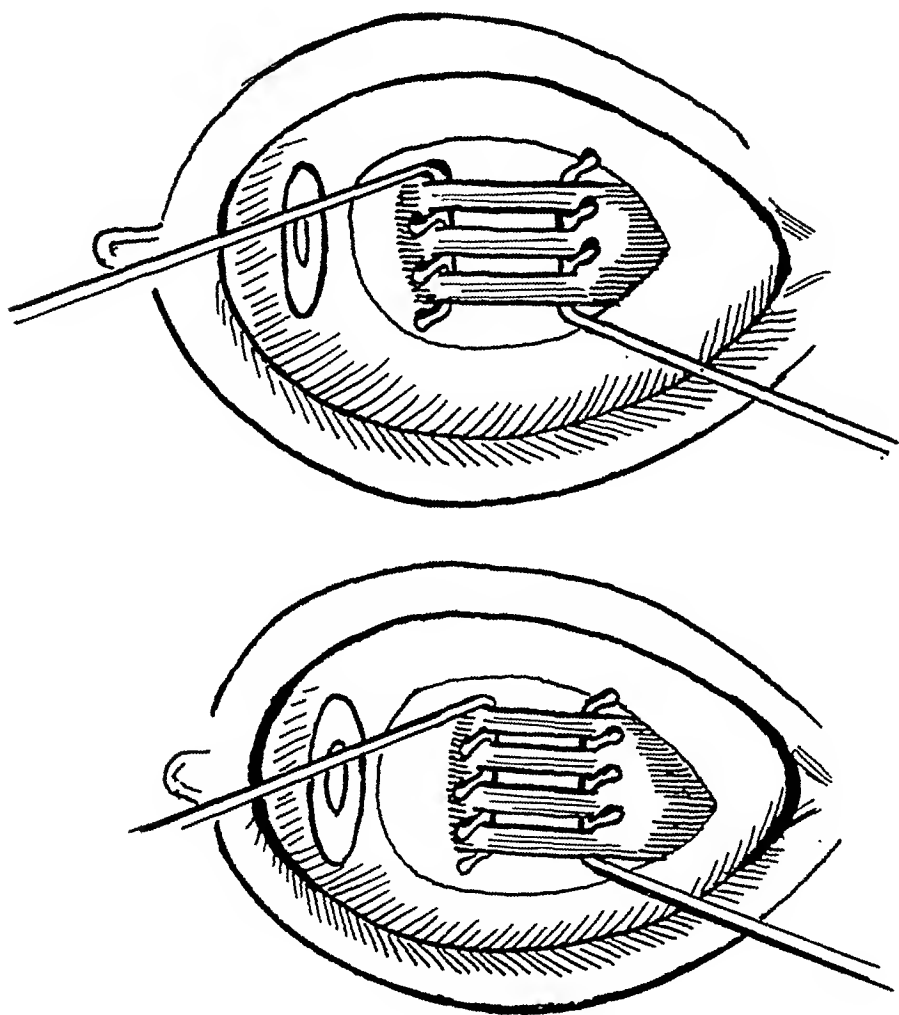


Fig. 5.—Three and four strand separators holding the strands apart and slightly elevated from the globe.

grooves. Then the second separator is moved to the other end of the divided muscle.

5. After the strands of tendon and muscle have been separated and slightly elevated from the globe, the separators are held in place at each end of the divided muscle by the assistant (fig. 5). The metal cable end (previously bent as desired) is now easily looped around the individual strands as often as is desired. When the looping on each strand is completed, the separators are removed (fig. 6). They come

out easily by reversing the procedure of insertion. The handle is turned down, then gently pushed downward and backward. This disengages the small uprights between the strands, and the instruments slide out from below the muscle, in the same manner as a muscle hook comes out. This procedure, complicated though it sounds, is simplicity itself in performance.

6. After the looping is finished on each strand and the separators are removed, the cable is pulled taut, and a tuck is completed. The

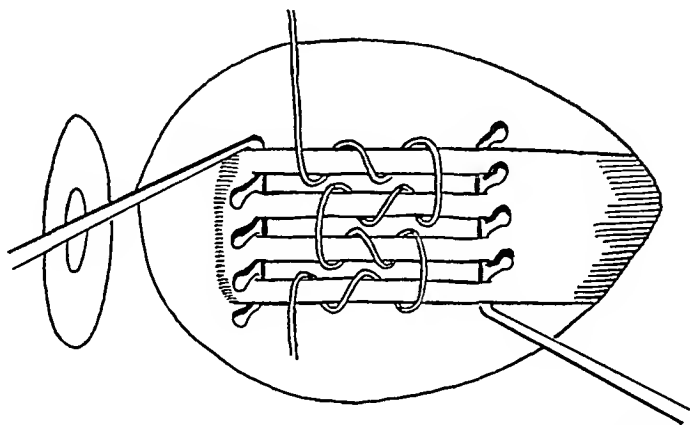


Fig. 6.—Diagram showing the cable double-looped around four strands of muscle, with the separators in place. These are removed when the looping is completed.

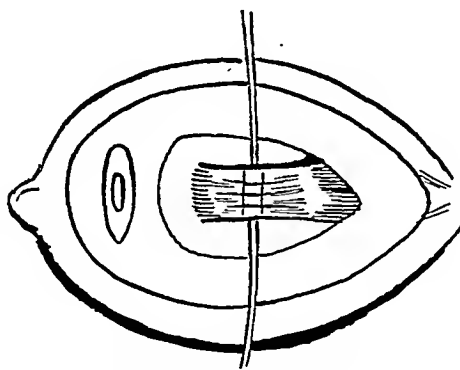


Fig. 7.—Diagram showing the cable pulled taut and the tuck completed.

looped strands of tendon and muscle are now pushed together by pressing the blunt hook at the upper margin of the muscle against a pair of forceps holding the cable at the lower margin (fig. 7).

7. The cable is cut 5 mm. above the upper margin of the tendon and 15 mm. below the lower margin. The conjunctival incision is closed with two or three silk sutures. The upper end of the shortener is buried under the conjunctiva. The lower end of the cable emerges from the incision to lie free in the sulcus.

8. The eyes are bandaged. The bandages are removed at the end of forty-eight hours, the silk sutures at the end of eight days and the cables at the end of fourteen days. It has been my experience that if the tendon and muscle have been properly prepared and the cable properly inserted around and between the strands, the cable slips out easily without the need of any local anesthetic.¹

DISCUSSION

DR. L. F. APPLEMAN: Dr. Smukler has given what I believe to be some valuable aids in performing the O'Connor operation. First, in fastening both ends of the strands by metallic cement one provides a sufficiently stiff end to weave among the strands of muscle without the aid of a special needle, which is rather difficult to thread with six or eight strands of dermal suture, and at the same time the distal ends are held together; consequently, they will not whip all over the field of operation during insertion.

Again, the use of hooks which will hold each strand of muscle separated from the other, and especially the pair of separators held at either end of the exposed muscle, will greatly simplify the passage of the strands of dermal suture between and around them.

I should consider these hooks a great help and not more difficult to disengage than the plain hook which is generally used. In my experience, the greatest trouble was encountered in keeping each strand of muscle separated, after it was longitudinally divided by the sharp hook, until the others were separated. Almost always the dividing line was lost while the next strand was being found. This can be overcome now by the use of the small projection on the hook.

I like the O'Connor operation, especially in cases of strabismus of from 10 to 15 degrees, and particularly in correcting vertical deviations. The operation is advantageous for the following reasons: There is little reaction; no unsightly lumps occur under the conjunctiva, which if present would be months in disappearing; the period of hospitalization is short, the patients being able to go home in two or three days, and the divided ends of the cable give little discomfort, as they lie well up in the cul-de-sacs and are normally removed at the end of two weeks simply by pulling them out a few at a time, or singly, without any discomfort.

I think that Dr. Smukler has done a service in devising these means of simplifying the technic.

1940 North Broad Street.

1. O'Connor, R.: The Cinch Shortening Loop in Surgery of the Extra-Ocular Muscles, *West. J. Surg.* 39:670 (Sept.) 1931.

PACKING OF INTERNAL CAROTID ARTERY WITH MUSCLE IN TREATMENT OF CAROTID-CAVERNOUS ARTERIOVENOUS ANEURYSM

E. S. GURDJIAN, M.D.

DETROIT

The management of carotid-cavernous arteriovenous aneurysm has received extensive discussion in the literature.¹ Various methods of treatment which have been used, some with greater success than others, are as follows: (1) ligation of the internal carotid artery or of the internal carotid artery and the common carotid artery on the affected side; (2) preliminary ligation of the internal carotid artery followed by intracranial ligation of the same artery;² (3) ligation of the veins in the orbit; (4) a direct attack on the apex of the orbit; (5) plugging of the fistula in the artery with muscle introduced into the blood stream of the internal carotid artery,³ and (6) injection of various substances with a view to helping clotting and eventual closure of the fistula in the affected artery and in other arteries. Treatment of this condition by ligation of the affected internal carotid artery has been found to be the most successful procedure.

The rationale of ligation of the carotid artery is to cause the formation of a blood clot which will eventually obliterate the fistula in the cavernous sinus. That this may be brought about by ligation of the internal carotid artery, or better still, by ligation of both the internal and the external carotid artery on the affected side, is well attested to by the excellent results obtained in fully 50 per cent of the cases.

In the case to be reported preliminary ligation of the common carotid artery at the junction of its internal and external branches on the right side proved to be a failure. The possibility of introducing small bits of muscle tissue into the blood stream of the internal carotid artery was considered. However, to insure against embolic phenomena it was thought more advisable to introduce a strip of muscle into the internal carotid artery and to plug the artery as high as possible by pushing the muscle toward the cranial cavity with an appropriate instru-

1. Locke, C. E.: Intracranial Arteriovenous Aneurysm or Pulsating Exophthalmos, *Ann. Surg.* **80**:1, 1924.

2. Dandy, W. E.: Treatment of Carotid Cavernous Arteriovenous Aneurysm, *Ann. Surg.* **102**:916, 1935.

3. Hamby, W. B., and Gardner, J. W.: Treatment of Pulsating Exophthalmos: Report of Two Cases, *Arch. Surg.* **27**:676 (Oct.) 1933.

ment. I felt that by this method there was little likelihood of bits of muscle breaking off and entering the venous circulation of the sinus. The results were so excellent that the case is presented as an argument in favor of primary plugging of the internal carotid artery with muscle, after one is sure that this can be done without cerebral complications. With this method a much shorter distance need be covered by the clot in order to effect eventual closure of the fistula in the artery. It is also reasonable to assume that the percentage of cures would be greater. Of course, plugging of the internal carotid artery with muscle is no different than ligation of the artery and only slightly more complicated.

REPORT OF A CASE

History.—M. B., a white man, entered the Grace Hospital on April 7, 1936, complaining of nausea, vomiting, swelling of the eyes and inability to elevate the upper lids. About a week before admission he suddenly became nauseated and vomited several times. The following morning he had a severe headache across the forehead. He complained of diplopia, and there was beginning swelling of the right eye. Two days later there was marked swelling of the right eye with inability to elevate the upper lid. Pulsations were felt in the head. In another three days there was swelling of the left eye.

Examination.—Twelve days after the onset of the condition examination showed marked eversion of the conjunctivas, especially the right; inability to elevate the upper lid of either eye, and inability to move either eyeball in any direction. There was slight dilatation of the pupil on the right side, with practically complete blindness. With a stethoscope, pulsations could be heard over the right eye, the forehead and the temporal region. There were no pulsations on the left side.

A diagnosis was made of spontaneous carotid-cavernous arteriovenous aneurysm on the right side.

Course.—For the next eight days digital pressure was applied to the right common carotid artery to obliterate it. At the beginning the pressure was applied for three minutes; the period was then increased, until on the eighth day the patient was able to stand half an hour of pressure without untoward symptoms. When this was accomplished he was ready for ligation of the internal and external carotid arteries.

Operation.—On April 17 the right common carotid artery and the internal and external carotid arteries were exposed, local anesthesia being used. A removable clamp was applied on the common carotid artery for forty-five minutes, with no untoward symptoms. The artery was then ligated at the junction of its two terminal branches.

There was marked diminution in the pressure of both orbits. The patient continued to show marked improvement in the left eye and moderate improvement in the right eye, and there was practically complete cessation of the pulsations in the head. He was discharged on April 27.

Second Admission.—He reentered the hospital on May 12, because of a return of practically all of the symptoms complained of at the first admission. There was a return of exophthalmos and marked eversion of the conjunctivas, so that the eyeballs could hardly be seen when the upper lids were elevated.

Second Operation.—On May 13 the carotid complex was reexposed on the right side. The junction of the common carotid artery and the external and internal carotid arteries was found to be completely thrombosed. Above this level the internal carotid artery was soft and evidently contained fluid blood. A rubber clamp was applied on the internal carotid artery, and a longitudinal incision 2 cm. in length was made. The index finger of the left hand was passed under the artery, and by pulling the finger toward the surface of the body the arterial lumen was easily obliterated. A previously obtained strip of muscle about 20 cm. long and 0.25 cm. in diameter was introduced into the lumen of the artery and



Fig. 1.—*A*, photograph of the patient on admission to the hospital, at which time he had bilateral exophthalmos, bilateral ptosis, complete paralysis of all extraocular muscles and practically complete blindness of the right eye. *B* and *C*., photographs of the patient fourteen months later. Complete return of the movements of the extraocular muscles, 50 per cent return of vision in the right eye, and complete disappearance of the pulsations in the head had taken place.

pushed upward with a probe. By this process the internal carotid artery became completely plugged up to the base of the skull. A ligature was then applied at the point of introduction of muscle.

Course.—The course in the hospital after the second operative procedure was uneventful. There was marked improvement in each eye. The bilateral exoph-

thamos receded practically completely within a week. In two weeks the patient was able to elevate the upper lids. In three months the movements of the extra-ocular muscles returned completely, and there was 50 per cent return of vision in the right eye. Photographs made on year and two months later showed an excellent result.

COMMENT

If the physician is satisfied that ligation of the carotid artery is the procedure of choice in the treatment of a given carotid-cavernous arteriovenous aneurysm, plugging of the internal carotid artery with

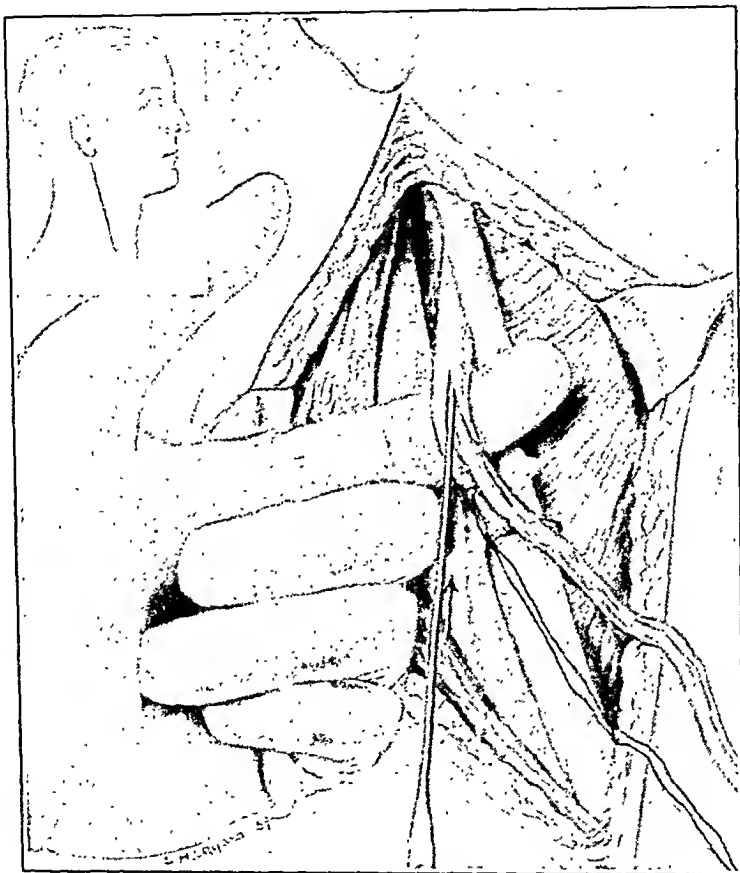


Fig. 2.—Diagrammatic representation of the technic for packing the internal carotid artery with muscle.

muscle seems a more reasonable procedure than mere ligation. The plug may easily be pushed as high as the base of the skull; hence a much shorter distance is left for further clotting in order to obstruct the fistula in the artery. The procedure is practically as simple as ligation of the carotid artery. A strip of muscle about 20 cm. long and 0.5 cm. in thickness may be obtained from the exposed sternocleidomastoid muscle. After exposure of the carotid complex, a clamp is applied below and above the area of incision of the internal carotid artery. The artery is then incised longitudinally, and the lumen is exposed. After the index finger of the left hand is passed under the incised artery,

the upper clamp is removed, and the bleeding is controlled by pressure from the index finger looping the artery. The strip of muscle is then pushed into the lumen with an appropriate probe. Every time the probe is removed to start the plugging procedure over again, the pressure by the index finger controls all the bleeding. On completion of the procedure the artery is ligated above and below the point of introduction of muscle.

SUMMARY

Packing of the internal carotid artery with muscle as high as possible affords a better opportunity for the cure of carotid-cavernous arteriovenous aneurysm. With this method a much less extensive blood clot is needed above the level of the muscle plug to effect eventual closure of the fistula in the artery. On theoretic grounds, at least, plugging of the internal carotid artery with muscle should be much more efficient in the treatment of this condition than mere ligation of the artery.

MAGNESIUM CONTENT OF CAPSULATED LENSES

A REVIEW OF ITS PROBABLE IMPORT; PRELIMINARY
REPORT

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The constantly increasing therapeutic use of magnesium salts, particularly in the United States, makes one consider whether or not harmful effects on the eye can be produced. Burge¹ had shown that the magnesium content of cataracts removed in this country was five times that of cataracts removed in India.

The possibility of a relation of intake of magnesium to pathologic changes in the lens was suggested by the following case:

R. K., a housewife aged 49, was first seen on Dec. 4, 1935, complaining of failing vision in each eye for the past year.

Examination disclosed soft mature cataracts, with good light projection. A search into all possible etiologic factors, which were present at the time or which may have existed in the formative period, failed to disclose any of a dietary, hereditary, metabolic, endocrinologic or toxic nature.

Three years previously, at a time when from the patient's point of view normal vision existed except for myopia which was corrected adequately by glasses, she experienced a digestive upset which caused her to seek the aid of her family physician. Magnesium oxide was prescribed to be taken three times daily. The immediate symptoms disappeared, but the patient continued to take the medicament as prescribed, unknown to her physician, until the day she presented herself for ophthalmologic examination. The possibility of a relation of the medication to the formation of cataract was uppermost in her mind, but at that time a conclusive opinion could not be given concerning this.

The amount of experimentation done to relate changes in the calcium content of the body to formation of cataract justifies some consideration of the relation of magnesium to calcium.

In reviewing the more outstanding data on the former, one finds the following observations:

1. Although the calcium content of bone as determined experimentally, the calcium content of the blood and the calcium metabolism

From the Ophthalmological Service of Dr. Webb W. Weeks, the Bellevue Hospital.

1. Burge, W. E.: Arch. Ophth. 38:435. 1909.

of patients with senile cataract are normal, the calcium content of the cataractous lens increases from an almost negligible quantity in the normal lens to 12.5 per cent (Berger). Mackay and his co-workers,² using 16 normal lenses, found 1.01 per cent of calcium ash as compared with 5.49 per cent in 16 lenses with senile cataract. Because of the greatly increased calcium content, they suggested that some special relation exists between calcium and the development of cataract.

2. In a study of the permeability of the capsule of the lens, Friedenwald³ found it higher than that of other biologic membranes, exceeding that of capillaries. Although it has not been definitely proved, he expressed the opinion that a decrease in capsular permeability in vivo leads to the formation of cataract. Exposure of the capsule to calcium chloride, potassium cyanide and egg albumin caused a reduction in the permeability.

3. Kirby⁴ found slight reductions in calcium toxic to a culture of epithelial cells of the lens, but an increase of calcium had no effect.

4. Burge⁵ and Hinrichs⁶ found that lenticular opacities were more readily produced in lenses by ultraviolet irradiation in the presence of calcium salts. This has not been sufficiently verified.

In an effort to point out the antagonistic relation of magnesium and calcium, the following observations may be cited:

1. A lowering of calcium produces a slight increase in magnesium. Equally true is the fact that administration of magnesium increases the elimination of calcium. On the other hand, anesthesia produced by intravenous or subcutaneous injection of magnesium chloride is counteracted by calcium salts.

2. A diminution of protein or an augmentation of phosphates results in a reduction of the calcium content of serum, whereas the magnesium content is unaffected.

3. Carswell and Winter⁷ expressed the belief that with an adequate intake of phosphorus administration of magnesium favors storage of calcium.

2. Mackay, G.; Stewart, C. P., and Robertson, J. D.: *Brit. J. Ophth.* **16**: 193, 1932.

3. Friedenwald, J. S.: *The Permeability of the Lens Capsule, with Special Reference to the Etiology of Senile Cataract*, *Arch. Ophth.* **3**:182 (Feb.) 1930; *The Permeability of the Lens Capsule to Water, Dextrose and Other Sugars*, *ibid.* **4**:350 (Sept.) 1930.

4. Kirby, D. B.: *Permeability of the Lens Capsule*, *Arch. Ophth.* **5**:856 (June) 1931.

5. Burge, W. E.: *Am. J. Physiol.* **36**:21, 1914.

6. Hinrichs, M. A.: *Proc. Soc. Exper. Biol. & Med.* **27**:535, 1930.

7. Carswell, H. E., and Winter, J. E.: *J. Biol. Chem.* **93**:411, 1931.

4. Parathyroid extract causes a loss of magnesium as well as of calcium, while parathyroidectomy is followed by a retention of magnesium.

5. Swingle and Wenner⁸ stated that although calcium and magnesium do not subserve the same functions within the organism they can be substituted for one another in the alimentary mixture. They found that parathyroidectomized animals could be preserved from tetany by the addition of magnesium salts to diets which would not of themselves prevent tetany if the salts were given before the calcium content of the serum had fallen. When the calcium content was low, however, magnesium salts did not prevent tetany. It was inferred that magnesium was substituted for the calcium in the excretion and that by that means absorption of calcium was promoted.

6. Muscle normally contains 21 mg. of magnesium per hundred grams of tissue, while only 7 Gm. of calcium is found in a like quantity of muscle. Bone contains one eighth as much magnesium as calcium. In the blood, calcium is found almost exclusively in the serum, while magnesium is equally distributed between serum and cells, if anything a slight excess being found in the corpuscles. Normally, from 2 to 3 mg. of magnesium per hundred cubic centimeters of serum against from 9 to 11 mg. of calcium is found. In whole blood cells the magnesium content is found to be from 2.3 to 4 mg. per hundred cubic centimeters of whole blood cells. In spinal fluid from 3 to 3.5 mg. of magnesium per hundred cubic centimeters is normally found. Duke-Elder,⁹ using intraocular fluids of the horse, found 100 cc. of aqueous to contain 0.0062 Gm. of calcium as compared with 0.0026 Gm. of magnesium, whereas in the vitreous he found 0.0068 Gm. of calcium as compared with 0.0020 Gm. of magnesium.

Fischer¹⁰ in 1933 by colorimetric measure found magnesium to be present in greater quantities than calcium in the normal lens and ciliary body of the calf, cow and pig, calcium being found in greater quantities than magnesium in the cornea, vitreous and sclera.

A still less understood relation exists between magnesium and sugar. Magnesium is a part of chlorophyll. The latter's part in carbohydrate building is now being thoroughly investigated. Lohmann has found that the retina has a higher percentage of sugar than other adult tissues and that magnesium "fait partie du coferment, de la glycolyse." Wolff and Bourquard,¹¹ studying the distribution of magnesium in the tissues of the eye, found that the retina had the highest magnesium content next to muscle tissue. They did not report on the magnesium in the lens.

8. Swingle, W. W., and Wenner, W. F.: *Proc. Soc. Exper. Biol. & Med.* **23**:432, 1926.

9. Duke-Elder, W. S.: *Text Book of Ophthalmology*, St. Louis, C. V. Mosby Company, 1933, vol. 1, p. 427.

10. Fischer, F. P.: *Arch. f. Augenh.* **107**:295, 1933.

11. Wolff, R., and Bourquard, A.: *Compt. rend. Soc. de biol.* **124**:319, 1937.

While glycosuria following the injection of magnesium sulfate was casually noted by Meltzer and Auer, the first careful study of the effect of magnesium in this direction was carried out by Underhill and Closson.¹² In the estimation of these workers the hyperglycemic action of magnesium is the result of a disturbance in respiratory action. Lang and Rigo injected from 25 to 100 mg. of a magnesium salt per kilogram of body weight and increased the dextrose concentration of the blood from 10 to 30 per cent. They assumed that the hyperglycemia is produced by the action of magnesium on the sympathetic nervous system.

A study of the relation of sugar to lens metabolism brings forth the following data:

1. Human lens contains 60 mg. of free dextrose per hundred cubic centimeters of lens (Lottrup-Andersen¹³).
2. The lens utilizes sugar.
3. Kronfeld and Bothman¹⁴ found lens sugar to be the same as blood sugar and reported that it was a hexose.
4. The capsule of the lens is highly permeable to dextrose and less so to sucrose and galactose.
5. Insulin increases the permeability of tissue.
6. The ratio of the sugar in the blood to that in the aqueous is 0.82, the sugar in the aqueous increasing when that in the blood increases. (Duke-Elder has held that cataract in association with diabetes is the result of abnormal fluid traffic.)

EXPERIMENTAL OBSERVATIONS

In this preliminary report on magnesium and cataract the first approach was in the nature of communications to mines where magnesite was worked to find out whether or not men who were daily in contact with magnesium had complained of visual disturbances. The replies were all in the negative.

Next a determination of the magnesium content of the blood serum of twenty-seven patients with cataract was undertaken by the Cohen-Briggs method.¹⁵ The highest recorded magnesium content in this group was 5.1 mg. per hundred cubic centimeters of serum, and the lowest value was 2.1 mg.

The patient whose condition stimulated this investigation had 4.8 mg. of magnesium per hundred cubic centimeters of serum (and after

12. Underhill, F. P., and Closson, O. E.: *Am. J. Physiol.* **15**:321, 1905.

13. Lottrup-Andersen, C.: *Acta ophth.* **5**:226, 1927.

14. Kronfeld, P. C., and Bothman, L.: *Ztschr. f. Augenh.* **65**:41, 1928.

15. Cohen, H.: *Quart. J. Med.* **20**:173, 1927.

taking no magnesium for five weeks, 4.5 mg.). The average reading was 3.3 mg. (Normally, the blood serum contains from 2 to 3 mg. of magnesium per hundred cubic centimeters of serum.)

Spaeth¹⁶ reported signs of tetany in a case of dinitrophenol cataract postoperatively. An opportunity was had to study the blood of a patient poisoned with dinitrophenol while acutely ill and showing jaundice. The magnesium content of the blood serum was 2.5 mg.

In 21 of the foregoing cases the calcium content of the blood serum was likewise determined. The lowest content was 9.2 mg. and the highest 11.5 mg. per hundred cubic centimeters (normal, from 9 to 11 mg.). The average content was 10.4 mg.

There was no correlation between the amount of magnesium and that of calcium. In cases in which both 2.1 and 5 mg. of magnesium were found the calcium content was 11 mg. per hundred cubic centimeters of serum.

Next the magnesium content of cataractous lenses removed in capsule at operation was determined. The method used was as follows:

The ash of a single lens was dissolved in 10 cc. of approximately tenth-normal hydrochloric acid in a centrifuge tube. Saturated ammonium oxalate was added, and the procedure was then carried out as for serum.¹⁵

Standard solutions containing 1, 2, 3, 4 and 5 cc. of Briggs' stock standard (containing 0.007 mg. of magnesium per cubic centimeter) should be made up for close comparison in the colorimeter. (When less than 5 cc. is used, one should make up to 5 cc. with hundredth-normal sulfuric acid.)

Eighteen lenses were analyzed. One removed at autopsy from a normal eye of a patient who died of pulmonary tuberculosis showed 0.014 mg. of magnesium in the entire lens.

For the cataractous lenses, the findings ranged from 0.006 to 0.028 mg. of magnesium, the average being 0.0163 mg. In the group were 2 black cataracts containing 0.010 and 0.028 mg. of magnesium, respectively.

From this analysis there appeared to be no variation from the normal magnesium content of lenses.

The lens of the patient taking magnesium oxide, removed by the extracapsular route, showed less than 0.0035 mg. of magnesium. This finding made necessary the explanation that possibly the capsule with the cortex that adhered to it must contain as much as if not more magnesium than was present in the expressed portion. Accordingly, 7 lenses removed intracapsularly were stripped of their capsules, and these together with some underlying cortex were placed in a porcelain crucible. In another crucible were placed the bulk of the lenses.

16. Spaeth, E. B.: *Am. J. Ophth.* **19**:320, 1936.

Determinations of the magnesium showed the following values: (a) 0.062 mg. in 7 capsules and adherent cortex and (b) 0.058 mg. in 7 nuclei.

To determine experimentally what effect magnesium taken orally could produce in the lens, two experiments were undertaken.

Patients with immature cataract which interfered appreciably with vision were given magnesium oxide to see if there was any appreciable acceleration in the maturing process. This was carried out in 10 cases. Observation over a year failed to disclose any changes that seemed to differ from the usual progress in such cases. None of the cataracts retrogressed; 6 showed no change during the period of observation.

The other method, which allowed for more accurate notation, consisted of feeding 3 white mice, 6 weeks old, of the same litter a diet that would not of itself produce cataract. One mouse was given 1 cc. of magnesium chloride (0.02 Gm. of magnesium) daily by mouth with an eye dropper. A second mouse was given twice this quantity of magnesium chloride, 2cc. (0.04 Gm. of magnesium). A third mouse of the same litter was not given any magnesium. This experiment was continued for eight months, after which the right eye of each rat was removed. Chemical analyses of the lenses showed the following data: The entire lens of rat A, fed no magnesium, contained 0.0038 mg. of magnesium; that of rat B, fed the smallest quantity of magnesium, 0.0043 mg., and that of rat C, fed the largest quantity of magnesium, 0.0062 mg.

The left eye was removed from each rat for histologic study and showed no evidence of cataract formation. The ciliary body, which normally contains a higher amount of magnesium, was likewise histologically normal.

SUMMARY

Blood serum of patients with normal lenses compared with the blood serum of patients with cataracts showed no appreciable difference in the magnesium content.

The amount of magnesium in the cataractous lens was not found to differ appreciably from that of a normal lens.

The amount of magnesium in the capsule and adherent cortex is greater than that in the remaining nucleus of the lens.

Two rats fed daily with varied amounts of magnesium over eight months had a higher magnesium content in their lenses than a rat given no magnesium.

CONCLUSION

Whereas an increased magnesium intake might increase the amount of magnesium in a lens, from our present knowledge we cannot infer any relation between intake of magnesium and formation of cataract.

A CLASSIFICATION OF CONCOMITANT STRABISMUS

RESULTS SECURED IN VARIOUS TYPES

GEORGE P. GUIBOR, M.D.

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A report of the possibilities of orthoptic training was presented before the Section on Ophthalmology of the American Medical Association in June 1933. A second report on the practical details in the orthoptic treatment of strabismus was presented in June 1934. These reports were based on observations made on two groups of patients. One, a control group at the Children's Memorial Hospital, received no orthoptic training, atropinization, occlusion of the fixing eye and a correction of the refractive errors being the only measures carried out. The second group, those seen at Northwestern University, were given orthoptic training. This report is a discussion of these two groups and of additional patients who were sent in for observation at the Children's Memorial Hospital and for observation and treatment at Northwestern University; every subject considered has been under observation for six months or longer.

The examination of the patients included: (1) determination of vision, with and without glasses; (2) determination of muscle balance, motility, the angle gamma and the angle of squint, and (3) determination of the degree of fusion.

The following classification of types of strabismus has been used for two years and has been of help in differentiating patients who will be aided materially by nonsurgical measures from those who must have operative correction.

1. Pseudoparalytic strabismus
2. Accommodative strabismus
3. Strabismus due to or associated with fusion defects
4. Strabismus due to or associated with amblyopia
5. Strabismus due to or associated with neuromuscular defects
6. Strabismus due to or associated with anisometropia
7. Strabismus due to or associated with multiple defects

This classification is not entirely original. Consultation of the works of the authors cited will verify this, though no one author has included

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all the salient points given in this outline. If squint is recognized as a symptom complex with multiple causes, to be treated by multiple therapeutic methods, the problem of diagnosis and treatment is not so difficult.

The classification of concomitant squint has been attempted by many authorities. Worth¹ discussed motility defects, especially sub-normal external rotation, which occurred in 19 per cent of 1,523 cases, and emphasized the undue shortness of the internal rectus muscles. His conclusions were that such defects are secondary and not the cause of squint.

Worth stated, however, that even though the essential cause of squint is a defective fusion ability, secondary or exciting causes exist, such as hyperopia, anisometropia, motor defects, amblyopia, mental disturbances, hereditary factors, birth injuries and specific fevers. He was aware therefore that secondary causes exist and are important in the treatment of squint.

Sheila Mayou² classified divergent squint according to the refractive errors present; in a group of 93 cases of divergent squint there were 48 cases of emmetropia, 26 cases of hypermetropia and 17 cases of myopia. The general conclusion was that small deviations, of 10 or 15 degrees, are relieved by orthoptic training; those over 15 degrees are relieved by surgical treatment plus orthoptic training. The prognosis is best in those cases of squint associated with emmetropia and poorest in those associated with myopia.

Pugh³ similarly classified a series of cases into instances of refractive error squint (62 per cent), fusion defect squint (15 per cent), psychologic squint (21 per cent) and physical defect squint (20 per cent).

The classification in this article was made independently but at the same time as those of the foregoing authors. I believe that a review of the tables presented will demonstrate this classification to be more complete than most classifications and will show those factors associated with squint which must be treated and overcome to produce recovery from strabismus.

Table 1 shows the relative value of tests for determining the types of squint. It can be seen that the diagnosis of the various types is made as follows: (1) pseudoparalytic squint, by simultaneous atropinization of each eye and determination of the motility; (2) accommodative squint, by atropinization of each eye, correction of the refractive error and measurement of the angle of squint for far and near vision, with and without glasses; (3) squint associated with fusion defects, by fusion

1. Worth, C. A.: *Squint*, London, Baillière, Tindall & Cox, 1921, p. 48.

2. Mayou, S.: *Brit. J. Ophth.* **19**:37 (Jan) 1935.

3. Pugh, M.: *Brit. J. Ophth.* **18**:446 (Aug.) 1934; *Squint Training*, London, Oxford University Press, 1936.

tests and by three attempts to train the patient to fuse when such ability apparently is absent or defective; (4) the amblyopic type of squint, by determination of the visual acuity; (5) strabismus associated with muscular defects, by studying the motility and measuring the angle of squint and by the use of prisms for constant wear, especially if a vertical deviation is present, and (6) the anisometropic type of squint, by determination of the refractive error.

TABLE 1.—*Relative Value of Tests for Determining Common Types of Squint*

Tests	Pseudo-paralytic Squint	Accommodative Squint	Squint Associated with			
			Defects in Fusion	Amblyopia	Muscular Defects	Anisometropia
Test for visual acuity	.....	.....	.....	Poor vision in one eye	.....	.....
Test for motility	Apparent paralysis of the external rectus muscles	.....	.....	.....	Under-action and over action disclosed	.....
Atropinization...	Appearance of external rotation	Decrease in squint	.....	.....	.....	.....
Refraction.....	.....	Decrease in angle of squint	.....	.....	.....	Unequal refractive error in each eye
Determination of angle of squint...	.....	Less for distant than for near vision	.....	.....	Variable	.....
Fusion tests.....	.....	Some fusion ability	Marked fusion defects	Total partial suppression of amblyopic eye	.....	Fusion of large objects only
Therapeutic tests with fusion training	.....	Normal fusion produced	Improvement in fusion	.....	.....	.....
Prism trial test...	.....	.....	.....	.....	Possible decrease in horizontal deviation on correction of the vertical deviation	.....

After the diagnosis of the type of squint has been made, the refractive errors are corrected as follows:

In cases of amblyopic squint of not too severe a degree the correction before the fixing eye is decreased so that when it is atropinized the visual acuity of this eye is equal to, or less than, that of the amblyopic eye (table 2).

In cases of accommodative squint a full correction is prescribed for distant vision and a bifocal addition of a plus 3.00 D. sphere for near vision. Atropinization of both eyes is done for from one week to a month and can be repeated at will.

In cases of anisometropic squint with equal visual acuity in each eye attempts may be made to equalize the difference in the size of the retinal images, after the methods outlined by Ames. Nothing has been done with this method in the clinics at Northwestern University and at the Children's Memorial Hospital.

In the series of charts which I have prepared at Northwestern University the card for measuring the size of the retinal images, as suggested by Dr. Andrews, may be used to measure roughly the difference in the size of the retinal images.

DIFFERENT TYPES OF SQUINT

Pseudoparalytic Strabismus.—Dodds⁴ and others have observed cases of pseudoparalytic squint. Dodds has compiled a bibliography covering most reports of cases of pseudoparalytic or congenital muscular

TABLE 2.—*Methods of Correcting Refractive Errors*

Amblyopic Type of Squint	Accommodative Type of Squint	Anisometropic Type of Squint
Amblyopic eye: Total correction	For distant vision: Total correction of ametropia in each eye	Correction of difference in size by methods of Ames (if necessary)
Fixing eye: Corrected to equal visual acuity under atropinization of the amblyopic eye	For near vision: Bifocal lenses +3.00 D. sph.	

squint during the last sixty years. He expressed the belief that the condition in such cases is true paralysis of the abducens nerve.

This condition is found in infants and apparently exists from birth. One eye converges, or both eyes converge simultaneously, and abduction ability seems reduced or absent. In the bilateral type both eyes appear immobile; the palpebral fissure is narrow, and there is an apparent enophthalmos. The diagnosis of bilateral paralysis of the abducens nerve is often made in these cases. When the eyes are atropinized, however, an alternating convergence of moderate severity (25 degrees) appears. Careful examination reveals the presence of almost normal abduction.

In cases of pseudoparalytic squint the prognosis regarding a cosmetic recovery by nonsurgical means is poor. Yet loss of visual acuity and the development of abnormal correspondence may be prevented by atropinization of the eyes.

The following case demonstrates this type of squint:

C. M., a girl aged 2 years, appeared in September 1933 at the Children's Memorial Hospital; she was of a family of 10 children, 1 other child being cross eyed. There was bilateral simultaneous convergence of 35 degrees. Each

4. Dodds, L.: Brit. J. Ophth. 10:649 (Dec.) 1926.

eye was apparently fixed in this position. No abduction ability could be elicited. A diagnosis of bilateral paralysis of the abducens nerve was made by three examiners. A 0.5 per cent solution of atropine sulfate was instilled into each eye twice a day for several weeks. When cycloplegia was complete, the abduction ability appeared. An alternating convergence of 35 degrees gradually became one of 50 degrees and was associated with an alternating sursumvergence of 20 degrees.

In June 1934 under cycloplegia with atropine, the retinoscopic findings were:

R. 4.00 D. sph. \ominus 2.00 cyl., axis 145

L. 5.25 D. sph. \ominus 1.50 cyl., axis 135

The prescription for glasses was as follows:

R. 2.75 D. sph. \ominus 2.00 cyl., axis 45

L. 4.00 D. sph. \ominus 1.50 cyl., axis 135

In June 1936 there was alternating convergence of 55 degrees with an alternating sursumvergence of 20 degrees, with and without glasses, for far or near vision. There was a slight defect in the abduction of the right eye.

A diagnosis of pseudoparalytic squint was made. Though hyperopia was present, the squint was unaffected by correction of the refractive errors; therefore, this is not of the accommodative type.

ACCOMMODATIVE STRABISMUS

The characteristics of accommodative convergent squint are:

1. It is associated with hyperopia.
2. The angle of squint decreases or disappears (*a*) under atropinization, (*b*) with correction of the hyperopia and (*c*) with distance fixation.
3. This type of squint is often associated with a moderately severe amblyopia, which disappears rapidly when the fixing eye is occluded.
4. It is associated with good fusion ability.

The technic, therefore, in treating this type of strabismus is purely orthoptic, which is understood to include refraction, atropinization of one or both eyes, occlusion and fusion exercises. A complete correction of the hypermetropia (determined under cycloplegia with atropine) is prescribed. Bifocal lenses with an addition of a plus 3.00 D. sphere for near vision are prescribed to relax the spasm of accommodation for near vision which is so often present in these cases.

It is important that the bifocal segment should extend 2 mm. above the lower line of the lid. Stereoscopic ability is usually present in this type. Development of fusion amplitude and of abduction power is necessary to produce parallelism of the visual axis in cases of uncomplicated accommodative squint. In such cases the visual axes are parallel or almost parallel with glasses, but there is squint for near vision or when the glasses are removed.

Surgical technic at first glance might seem a satisfactory method for eliminating accommodative squint and also the use of unsightly convex

lenses. For the youthful subject the weakening of the internal rectus muscles by recessions might seem to produce no handicap or strain when the accommodation is powerful. But when the patient becomes more mature and a relaxation of accommodation and its associated relaxation of convergence occurs, a true convergence insufficiency or a divergent squint may occur.

STRABISMUS DUE TO OR ASSOCIATED WITH FUSION DEFECTS

Concomitant squint may be due to a fusion defect. Most patients with squint have some difficulty in fusion and may be unable to achieve it when first examined. Most of them, however, acquire the ability rapidly. Worth⁵ expressed the belief that a defect in fusion is the primary cause of squint in most cases. On the other hand, Hansell and Reber⁶ stated that this inability to fuse at first is a suppression rather than an absence of the fusion faculty.

In cases of alternating squint with little or no refractive error and with normal vision in each eye it seems likely that the faculty of fusion might be inferior to that of normal persons. That it is not entirely absent, however, is demonstrated by the patients with alternating squint who were seen at the orthoptic clinic at Northwestern University. Four of 7 patients have developed stereoscopic ability. Three have been unable to do so and have alternating monocular vision (pseudobinocularism).

With these facts in mind, a rigorous method of examination for fusion defects must be adopted before a diagnosis of defect or absence of fusion ability is made. For this purpose I have adopted the following criteria for the absence or defect of fusion ability: 1. Depth perception with the Howard apparatus is absent or much defective. 2. Stereoscopic ability with the amblyoscope, synoptophore and stereoscope is absent or defective after four trials, each trial extending over fifteen minutes.

With such a routine, few patients (15 per cent) are found with an absence of fusion faculty or a marked reduction in ability after several fusion exercises.

STRABISMUS DUE TO OR ASSOCIATED WITH AMBLYOPIA

It is certain that the term amblyopia is interpreted differently by different authors. Some believe that it is a mere difference in visual acuity between the two eyes, readily amenable to treatment. Others

5. Worth,¹ p. 56.

6. Hansell, H. F., and Reber, W.: *Ocular Muscles*, Philadelphia, P. Blakiston's Son & Co., 1912, p. 166.

consider it a condition in which there is marked loss of vision, without a visible defect, not amenable to treatment. A third view is based on a combination of these extremes. In this group the amblyopia may be the cause of the squint or may only be associated with the deviation of the eye.

Peter⁷ and Abraham⁸ and many others have attempted to classify amblyopia. No matter what conception of this disorder one possesses, one finds several types. A type found in young children which seems to be a suppression disappears completely and spontaneously as soon as glasses are prescribed. This, of course, should not be considered true amblyopia. A second type improves after atropinization and occlusion of the fixing eye. The third type is not amenable to treatment, and though definite improvement in the visual acuity cannot be determined, the patient recognizes objects better after occlusion of the fixing eye than before. Stereopsis of large objects may be present in all types. For example, if the unaided visual acuity is 20/25 in the right eye and 20/50 in the left eye, and with the appropriate correction, which is equal in the two eyes, at the time of refraction the vision is 20/20 in the right eye and 20/20 in the left eye, the condition is not true amblyopia but a temporary suppression.

On the other hand, if the visual acuity of the amblyopic eye is unimproved for several weeks and then gradually improves without occlusion and atropinization of the fellow eye to 20/40 or better, I should consider the condition suppression amblyopia. Again, if occlusion and atropinization are necessary to obtain improvement of vision, true amblyopia apparently exists.

In a third type of amblyopia the visual acuity in the amblyopic eye is 20/200 or less and rarely improves. If improvement in vision occurs, it is seldom for more than one or two lines of the Snellen chart. This is especially true of amblyopic squint associated with false projection and with poor fixation or absence of fixation. This third type of amblyopic squint is usually associated with (1) a high or low degree of deviation and (2) much variation of the angle of squint, especially if false projection is present.

STRABISMUS DUE TO OR ASSOCIATED WITH NEUROMUSCULAR DEFECTS

I am not attempting to say that defective abduction of a convergent eye or defective adduction of a diverging eye is a result or a cause of the squint. In similar manner an overacting internal rectus or oblique muscle may be the cause of or may coexist with the deviation. The

7. Peter, L. C.: *Am. J. Ophth.* **15**:493 (June) 1932.

8. Abraham, S.: *Amblyopia: Classification, with a Report of Cases*, *Arch. Ophth.* **12**:39 (Sept.) 1934.

important point is that these defects exist and must be partially or completely overcome to produce a satisfactory recovery from the strabismus.

The types of squint associated with muscular defects can be subdivided roughly as follows: (*a*) those associated with horizontal defects, (*b*) those associated with vertical defects and (*c*) those associated with combined horizontal and vertical defects.

A careful study of the neuromuscular coordination and the ability of a person with squint to maintain an extreme position of abduction during the objective examination is important, because, it will give an insight into the prognosis and the routine treatment in such a case. Sometimes the motility of the eyes must be determined at least six different times without cycloplegia and once under cycloplegia before a definite decision can be made that a neuromuscular defect exists. The reason for suggesting repeated examination is that defects may not be present at all times or may be overlooked during a single examination but may appear if examinations are repeated. Determination of the motility under atropinization may also disclose a defect to be spastic rather than structural. That is, overaction of an internal rectus or an inferior oblique muscle may be due to a spasm of these muscles and not to an abnormal structural shortening. This is not common.

Monocular and binocular determination of the motility are also important, because a defect may be absent binocularly, yet a marked neuromuscular defect may exist monocularly.

The differential diagnosis between spasm of a muscle and a definite defect in length is extremely important. A convergent spasm may become less or disappear when the eyes are atropinized, while an anatomic defect will not change materially.

The most simple type of defective motility is that in which no sclera is visible between the canthus and the limbus in abduction or adduction but a marked nystagmoid movement is present. In other cases the hyperadduction may be associated with a moderately high degree of accommodative convergence, which relaxes gradually under cycloplegia.

As a vertical component enters into a case, the prognosis usually becomes worse, and operative intervention may become necessary. For example, suppose a convergent squint is associated with overaction of the internal rectus and the inferior oblique muscle and also with underaction of the external rectus muscle. Such a condition affords a poorer prognosis than when underaction of the external rectus muscle exists alone.

Even though orthoptic training in cases of the muscular defect type of squint may produce parallelism of the visual axis, recurrence of the squint is the rule, because good duction power cannot always be developed.

ANISOMETROPIC STRABISMUS

Persons with anisometropia sometimes complain of an incongruity of the retinal images. Ames and Ogle⁹ discussed the size and shape of the retinal images. They expressed the belief that a difference in the size and shape of the retinal images as low as 0.5 per cent may produce the asthenopic symptoms of headaches and photophobia.

Bielschowsky¹⁰ reported a case of strabismus due to incongruity of the retinal images in which relief was obtained when the aniseikonia was corrected by proper lenses. There seems no doubt, therefore, that in some cases strabismus is associated with such abnormalities. Persons with aniseikonia and without other abnormalities, such as defects in vision, motility or fusion, are placed in this group. In such cases, when vision is good attempts should be made to correct the difference in the size of the retinal images by the method of Ames and his associates. As yet nothing has been done in this direction in the orthoptic clinics at Northwestern University and at the Children's Memorial Hospital.

Anisometropic and aniseikonic strabismus should be included in the classification for completeness. Nothing definite as yet can be said regarding aniseikonia and its association with strabismus.

COMMENT

During the last three years 354 persons with nonparalytic strabismus were admitted to the orthoptic clinic of the Children's Memorial Hospital, and 156 persons with the same type of strabismus were admitted to the orthoptic clinic of Northwestern University. Because of poor attendance and insufficient data, only 148 persons from the former clinic (group 1) and 65 from the latter (group 2) are considered to furnish suitable data for this report.

In table 3 are presented the results obtained in cases of all types of squint in group 1 by correction of the refractive errors, atropinization of one or both eyes and occlusion of the fixing eye; no fusion training is noted. These results are recorded with reference to the improvement in the angle of squint.

Thus in this group of 148 patients those with certain types of squint, such as squint associated with muscular defects and squint associated with muscular defects and amblyopia, did not recover, whereas 9 per cent of those with squint associated with fusion defects recovered and 15 per cent of those with squint associated with amblyopia recovered. Recovery occurred in 70 per cent of those with the accommodative type of stra-

9. Ames, A., Jr., and Ogle, K. N.: Size and Shape of Ocular Images: Visual Sensitivity to Differences in the Relative Size of Ocular Images of the Two Eyes, *Arch. Ophth.* 7:904 (June) 1932.

10. Bielschowsky, A.: *Am. J. Ophth.* 18:925 (Oct.) 1935.

bismus, and in 74 per cent of those with the accommodative-amblyopic type.

These figures also disclose the interesting fact that as the accommodative factor becomes associated with those types of squint which do not respond readily to nonsurgical treatment, the percentages of recoveries increases. Thus 20 per cent of the persons with the accommodative muscular defect type recover, whereas none of those with the pure muscular defect type recover.

TABLE 3.—Results in a Control Series According to Type of Squint

Types of Squint	No Improve-		Recovery, No. of Cases	Total	Recovery, Per- centage
	ment, No. of Cases	ment, No. of Cases			
Pseudoparalytic type.....	3	..	..	3	0
Amblyopic type.....	11	..	2	13	15
Accommodative type.....	2	7	21	30	70
Muscular defect type.....	12	2	0	14	0
Anisometropic type, with retinal images of differ- ent size.....	1	..	1	2	50
Fusion defect type.....	10	..	1	11	9
Combined types					
Accommodative-muscular type.....	16	4	5	25	20
Accommodative-amblyopic type.....	6	1	20	27	74
Muscular-amblyopic type.....	10	..	..	10	0
Muscular-accommodative-amblyopic type.....	5	4	1	10	10
Undiagnosed (instabilities).....	2	..	..	2	0
Multiple combinations.....	1	..	..	1	0

TABLE 4.—Results of Orthoptic Training Given According to the Type of Squint

Types of Squint	No Improve-		Recovery, No. of Cases	Total	Recovery, Per- centage
	ment, No. of Cases	ment, No. of Cases			
Pseudoparalytic type.....	1	..	..	1	0
Amblyopic type.....	4	2	4	10	40
Accommodative type.....	1	0	5	6	83
Muscular defect type.....	9	2	2	13	15
Anisometropic type.....	0	2	2	13	50
Fusion defect type.....	2	0	0	2	0
Accommodative-muscular type.....	1	2	3	6	50
Accommodative-amblyopic type.....	2	0	9	11	82
Muscular amblyopic type.....	7	0	2	9	22
Muscular-accommodative-amblyopic type.....	3	0	0	3	0
Multiple combinations.....	1	..	..	1	0
Undiagnosed (instabilities).....	0	1	0	1	0

In table 4 are presented the results of orthoptic training in cases of squint at Northwestern University (group 2). The training extended from five months to two years. Results are recorded as "no improvement," "improvement" and "recovery." There must be an absence of squint for far and near vision but not for distant vision alone before recovery is considered complete.

Even though it is usually thought that the chances for recovery decrease with increasing age, group 2 contains more subjects of advanced years than group 1. Yet, 15 per cent of those with squint associated

with muscular defects recovered and 22 per cent of those with squint associated with muscular defects and amblyopia recovered. It will be remembered that the younger patients with these two types of squint (group 1) who had no fusion training did not recover. Of those in group 2 with the amblyopic type of squint, 40 per cent recovered; in group 1, only 15 per cent recovered. Of those in group 2 with the accommodative type of squint, 83 per cent recovered, while in group 1, 70 per cent recovered.

The inevitable conclusion is: Fusion training has a definite favorable influence on most types of strabismus, even though the angle of squint does not entirely disappear.

Table 5 contains a record of the results in those cases previously classified with reference to the degree of squint. This table is important,

TABLE 5.—*Frequency of Recovery in Cases of High and Low Degree of Squint*

Types of Squint	Group 1 Children's Memorial Hospital				Group 2 Northwestern University			
	Over 15°	15° or Less	Total	Recov- ery	Over 15°	15° or Less	Total	Recov- ery
Pseudoparalytic type.....	3	0	3	0	1	0	1	0
Amblyopic type.....	10	3	13	2	3	7	10	4
Accommodative type.....	19	11	30	21	3	3	6	5
Muscular defect type.....	12	2	14	0	10	3	13	2
Anisometropic type.....	2	0	2	1	0	2	2	1
Fusion defect type.....	10	1	11	1	1	1	2	0
Accommodative-muscular type.....	19	6	25	5	4	2	6	3
Accommodative-amblyopic type.....	19	8	27	20	3	8	11	9
Muscular-amblyopic type.....	10	0	10	0	5	4	9	2
Muscular-accommodative-amblyopic type....	9	1	10	1	2	1	3	0
Multiple combinations.....	1	0	1	0	0	1	1	0
Undiagnosed (Instabilities).....	2	0	2	0	1	0	1	0

because it discloses that most persons in groups 1 and 2 with strabismus of the pseudoparalytic, muscular defect and fusion defect types have squint of over 20 degrees. This high degree might explain why so few of these patients recover, there being none in group 1 who recovered and only 2 in group 2. But this conclusion must be incorrect, because 19 of 30 persons in group 1 with the accommodative type of squint had squint of over 15 degrees and yet 21 recovered, 6 of those being persons with over 20 degrees of squint. There was an equal number of persons with a low and high degree of squint of the accommodative type in group 2 and yet only 1 of those with over 15 degrees of squint failed to recover with fusion training. Similarly, of those with squint of the accommodative-amblyopic type in group 1, 19 of 25 had over 15 degrees of squint. It must be concluded, therefore, that in cases of strabismus associated with muscular defects recovery is poor because of a weak musculature which cannot be improved by duction training. This condition is classified as a divergence insufficiency in association with convergent strabismus. With this same classification (Duane's), in most cases the accommodative type of squint may be considered due to

convergence excess if the squint is convergent and to divergence excess if it is divergent. Hence it must be conceded that though the degree of squint has an effect on the recovery of strabismus, other factors, such as poor motility power, are equally important.

In table 6 the frequency of occurrence of each type of squint and the frequency of recovery in both groups are recorded in percentages. It can be seen that the muscular, the amblyopic and the muscular-amblyopic types of squint occur only half as frequently in group 1 (average age, 6 years) as in group 2 (average age, 10). These are the types of strabismus in which spontaneous recovery seldom occurs and in which the prognosis with nonoperative treatment is poor. This observation that the severe types of squint occur more often in older persons should stimulate those interested in orthoptic training to begin such procedures early. The fact that 40 per cent of persons with the

TABLE 6.—*Percentages of Types of Squint in Both Groups; Percentages of Recovery*

Types of Squint	Group 1		Group 2	
	Incidence	Recovery	Incidence	Recovery
Pseudoparalytic type.....	2.0	0	1.53	0
Amblyopic type.....	87.0	15	15.33	0
Accommodative type.....	20.0	70	9.1	83
Muscular defect type.....	9.39	0	20.0	15
Anisometropic type.....	1.28	50	3.07	50
Fusion defect type.....	7.43	9	3.07	0
Accommodative-muscular type.....	16.89	20	9.23	50
Accommodative-amblyopic type.....	18.24	74	16.92	82
Muscular-amblyopic type.....	6.75	0	13.84	22
Muscular-accommodative-amblyopic type.....	6.75	10	4.6	0
Multiple combination.....	0.6	0	1.53	0
Undiagnosed (instabilities).....	1.3	0	1.53	0

amblyopic type of squint and 15 per cent of those with the muscular defect type recover by fusion training should stimulate one to attempt such training before considering surgical procedures.

The accommodative and the accommodative-muscular type of squint were almost twice as frequent in group 1 as in group 2. Here, too, fusion training is seen to be of benefit.

CONCLUSIONS

A classification of the types of nonparalytic squint is presented. This is not considered an all-inclusive classification but is offered as a convenient basis for determining the type of treatment.

Although the muscular defect, amblyopic and muscular-amblyopic types of strabismus are not benefited as much by nonsurgical treatment as the accommodative type and its combination, orthoptic training improves the condition in many cases.

The degree of squint affects the results secured by nonsurgical measures, but other factors, such as defects in motility, defects in vision and defects in fusion, may equally prevent recovery.

VITAMIN C AND ITS RELATION TO CATARACT

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The excellent experimental work and reviews which have appeared, especially in the last two years, from the department of ophthalmology of Northwestern University Medical School have increased the interest in the possible relation between the onset of cataract and the body stores of vitamin C (cevitamic acid). Delay in the development of cataract, possibly through dietary means, is a matter of such practical importance that a study of patients available in the Strong Memorial Hospital and the Rochester Municipal Hospital seemed worth while.

A brief summary of the literature may well precede a report of our laboratory findings. Bourne,¹ in her recent discussion of metabolic factors in the production of cataract, stated that "the physical and metabolic integrity of the lens is to some extent dependent upon the maintenance of a normal metabolism of the whole organism. General metabolic disturbance may affect the lens by creating a deficiency of some substance essential to lens metabolism by producing toxic substances, by altering the composition of the aqueous in respect to the water, salt or hydrogen ion concentration or by other metabolic disorders as yet unknown." Bourne considered all possible factors which might alter the normal metabolic function of the lens. We here confine ourselves to but one phase—the possible relation of cevitamic acid.

Glick and Biskind² stated: "The lens of the eye, having no blood supply, is especially dependent on those intracellular substances which form oxidation-reduction systems for the maintenance of many of its metabolic processes." They tabulated the concentration of cevitamic acid in the lenses of a number of animals as reported by various workers and found a range from 2 mg. per hundred grams of tissue in the rat

*Working under a grant from the California Fruit Growers Exchange.

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1. Bourne, M. C.: Metabolic Factors in Cataract Production, *Physiol. Rev.* **17**:1 (Jan.) 1937.

2. Glick, D., and Biskind, G. R.: Studies in Histochemistry: X. Distribution of Vitamin C in the Lens of the Eye, *Arch. Ophth.* **16**:990 (Dec.) 1936.

to 104 mg. in fish. The value for the lens in man is given as 31 mg.³ This agrees with the work of Müller and Buschke,⁴ who found the normal human lens to contain 30 mg. of cevitic acid per hundred grams of tissue. This high percentage of vitamin C in the lens of the human eye naturally raises the question as to its origin and function. Why should vitamin C be found in much lower concentrations in the cataractous lens? Bellows⁵ has reported that subjects with cataract have a lower concentration of cevitic acid in the blood than do normal subjects, an average of 0.605 mg. per hundred cubic centimeters for the group with cataract against 1.02 mg. for the group of normal subjects. Single morning specimens of urine showed a lower excretion of vitamin C for his six patients with cataract than for six normal persons of a corresponding age, the amount excreted being expressed as milligrams of vitamin C per cubic centimeter of urine.

Glick and Biskind² have demonstrated that age in itself is a factor in establishing the level of cevitic acid in lens as well as in other tissues. They found the level of vitamin C in the lens of a cow to be from 10 to 15 per cent lower than that in the lens of a calf. Such a difference has been found by various writers for all other tissues. Those tissues which have the highest metabolic activity or those taken from the growing young are always higher in vitamin content than the tissues of mature animals. The vitamin C content of mature and immature cataract,⁶ however, is much too low to be accounted for by the factor of age alone.

The ability to produce cataract in the albino rat through poisoning with naphthalene,⁷ or with excessive amounts of galactose, as first employed by Mitchell and Dodge,⁸ has made possible studies of the effect of the administration of vitamin C on the onset of cataract. Bellows⁹ was able to show that the administration of cystine and, to

3. von Euler, H., and Malmberg, M.: Neue Versuche über Ascorbinsäure (C-Vitamin) in tierischen Augenlinsen, *Arch. f. Augenh.* **109**:225, 1935.

4. Müller, H. K., and Buschke, W.: Vitamin C in Linse, Kammerwasser und Blut bei normalem und pathologischem Linsenstoffwechsel, *Arch. f. Augenh.* **108**:368, 1934.

5. Bellows, J.: Biochemistry of the Lens: V. Cevitic Acid Content of the Blood and Urine of Subjects with Senile Cataract, *Arch. Ophth.* **15**:78 (Jan.) 1936.

6. Bellows, J.: Biochemistry of the Lens: VII. Some Studies in Vitamin C and the Lens, *Arch. Ophth.* **16**:58 (July) 1936.

7. Müller, H. K.; Buschke, W.; Gurewitsch, A., and Brühl, F.: Vitamin C in Kammerwasser und Linse: Seine Bedeutung für Physiologie und Pathologie des Linsenstoffwechsels, *Klin. Wchnschr.* **13**:20 (Jan. 6) 1934.

8. Mitchell, H. S., and Dodge, W. M.: Cataract in Rats Fed on High Lactose Rations, *J. Nutrition* **9**:37 (Jan.) 1935.

9. Bellows, J.: Biochemistry of the Lens: IX. Influence of Vitamin C and Sulphydryls on the Production of Galactose Cataract, *Arch. Ophth.* **16**:762 (Nov.) 1936.

a lesser extent, of vitamin C delayed the onset of the cataracts in the experimental groups. He wrote: "Galactose in some way causes a loss of the sulfhydryl content of the crystalline lens. . . . If it could be shown that they diminish in amount before the opacities in the lens appear, this, coupled with the fact that an excess of these substances in the diet delays the onset of opacities, would make it reasonably certain that the loss of these substances is responsible for cataract formation." Von Euler and Malmberg³ found the vitamin C content of the lens of normal rabbits and guinea pigs to be 16 mg. per hundred grams, while the value for the lens of such animals rendered scorbutic by dietary restriction was diminished to 10 and 0.5 mg., respectively. The administration of large doses of vitamin C raised the level as high as 26 mg. They further reported that the value of 31 mg. for the normal human lens is diminished to 5 mg. by the presence of cataract.

A further experiment by Bellows⁹ showed a diminished quantity of sulfhydryls (glutathione and cysteine) but little change in the vitamin C content before there was any visible change in the lens. Since, however, vitamin C to some extent delayed the onset of cataract, "one is led to believe that the sulfhydryls and vitamin C are partially interchangeable in carrying out oxidation and reduction in the crystalline lens. Thus, as the sulfhydryl content diminishes, vitamin C, if available, will take over more and more of this function and will keep the lens more or less viable for some time. One may theorize that senile cataract in man may arise in a similar way . . ."

The question as to whether the absence of cevitic acid precedes the formation of cataract or is a result of it cannot yet be answered. The possibility of a low vitamin C content predisposing to the formation of cataract suggests itself.

A question arises here, as with other determinations of cevitic acid by titration with 2,6-dichlorophenolindophenol: Is the method specific for cevitic acid, especially when it is so closely associated with large amounts of glutathione and cysteine? Conflicting reports appear, but again one turns to the experiments of Bellows and Rosner,¹⁰ who by the use of the enzyme from the Hubbard squash found that at p_H 2 the reduction of the dye is due to vitamin C. This confirms the experiments of Demole and Müller,¹¹ who found the vitamin C content, as indicated by the biologic test, to be in good agreement with that indicated by the chemical test, if loss of vitamin C during handling were

10. Bellows, J., and Rosner, L.: *Biochemistry of the Lens: VIII. New Proof of the Presence of Vitamin C in the Crystalline Lens*, *Arch. Ophth.* **16**:248 (Aug.) 1936.

11. Demole, V., and Müller, H. K.: *Ueber das Vorkommen von Ascorbinsäure in Linse und Kammerwasser*, *Biochem. Ztschr.* **281**:80, 1935.

prevented. This also further confirms the observations on the chemical method for the estimation of vitamin C by Ahmad.¹²

In the present study patients admitted to the ophthalmologic service of the Strong Memorial Hospital were followed. It is unfortunate that complete data are not available for all. The vitamin C content of the blood was determined for 43 patients; of the urine, for 48 patients, and of the lens, for 36 patients, but complete studies were made on only 16. The data are tabulated for convenience and presented in the tables, the average values for the entire group being used in all tables except table 4, which contains the complete data on 16 patients.

The values for the lens are expressed as milligrams of cevitic acid per hundred grams of moist lens; for the blood, as milligrams per hundred cubic centimeters of whole blood, and for the urine, as total milligrams in a twenty-four hour specimen. The values for the blood were obtained on patients during fasting. No source of vitamin C was given during the collection of the "basal" specimens of urine, since it was desired to ascertain the saturation level at the time of the patients' admission to the hospital in order to obtain the full effect of the previous dietary habits on the stores of the vitamin C in the body tissues.

Methods of ascertaining the cevitic acid content of the blood, urine and tissue are reported elsewhere.¹³

From the data presented in the tables it can be seen that in our series there is no correlation between the vitamin C content of the lens and the age of the patient or between the age or the vitamin C content of the urine and the vitamin C content of the lens, but that there is a correlation between the vitamin C content of the urine and that of the blood.

There is a possible correlation between age and the vitamin C content of the blood, as indicated in table 1. If one calculates the average age of the cataractous and normal patients studied by Bellows,⁵ one finds that with the difference in the vitamin C content of the blood in the two groups there is correspondingly an age difference. The group of cataractous patients, with an average vitamin C content of the blood of 0.605 mg. per hundred cubic centimeters, have an average age of

12. Ahmad, B.: Observations on the Chemical Method for the Estimation of Vitamin C, *Biochem. J.* **29**:275, 1935.

13. (a) Hawley, E. E.; Stephens, D. J., and Anderson, G. K.: The Excretion of Vitamin C in Normal Individuals Following a Comparable Quantitative Administration in the Form of Orange Juice, Cevitic Acid by Mouth and Cevitic Acid Intravenously, *J. Nutrition* **11**:135 (Feb.) 1936. (b) Stephens, D. J., and Hawley, E. E.: Partition of Reduced Ascorbic Acid in the Blood, *J. Biol. Chem.* **115**:653 (Oct.) 1936. (c) Hawley, E. E.; Daggs, R. G., and Stephens, D. J.: Effect of the Administration of Acid and Alkaline Salts upon the Ascorbic Acid Content of Guinea Pig Tissues, *J. Nutrition* **14**:1 (July) 1937.

66, while the group of normal subjects, with an average vitamin C content of the blood of 1.02 mg. per hundred cubic centimeters, average 14 years younger.

Specimens of urine obtained under basal conditions with one exception showed a vitamin C content below normal (average, 9 mg. for a twenty-four hour specimen). Specimens of blood obtained under basal conditions with one exception showed vitamin C contents in the lower

TABLE 1.—Average Values for Vitamin C Tabulated on the Basis of Age

Age	Vitamin C Content of Blood, Mg. per 100 Cc.	Number of Patients	Vitamin C Content of Lens, Mg. per 100 Gm.	Number of Patients	Vitamin C Content of Urine, Mg. per 24 Hr. Specimen	Number of Patients
Under 20	1.03	10	..	..	13	15
21-30	1.12	5	13	1	12	4
31-40	1.02	1	16	2	12	2
41-50	0.94	1	11	1	7	1
51-60	0.98	7	23	9	10	5
61-70	0.91	12	21	9	12	13
71-80	0.88	5	16	11	6	6
Over 80	0.96	2	10	1	7	2

TABLE 2.—Data Tabulated on Basis of Vitamin C Content of Urine

Vitamin C Content of Urine, Mg. per 24 Hr. Specimen	Vitamin C Content of Blood, Mg. per 100 Cc.	Number of Patients	Vitamin C Content of Lens, Mg. per 100 Gm.	Number of Patients	Average Age	Number of Patients
Under 5	0.85	8	24	5	66	9
6-10	0.89	12	15	4	59	12
11-15	1.08	11	25	2	43	10
16-20	0.86	1	..	..	51	2
21-25	1.01	3	14	2	54	4
26 and over	0.92	1	..	..	65	1

TABLE 3.—Data Tabulated on Basis of Vitamin C Content of Lens

Vitamin C Content of Lens, Mg. per 100 Gm.	Average Age	Number of Patients	Average Vitamin C Content of Lens, Mg. per 100 Gm.
Under 10 mg.....	37.0*	1	9.4
10-15 inclusive.....	64.5	16	13.23
16-20.....	67.6	5	18.20
21-25.....	61.5	6	23.26
26-30.....	66.0	2	29.75
31-35.....	65.0	4	34.20
36 mg. and over.....	58.0	2	42.50 and 66.00†

* The patient had a traumatic cataract.

† The patient had leukemia; the vitamin C content of the blood was 5.9 mg. per hundred cubic centimeters (footnote 13^b).

normal range (average, 0.97 mg. per hundred cubic centimeters). The values for the vitamin C contents of the lens were distributed as follows: 1 above normal (30 mg. per hundred grams), 2 normal, 5 from 20 to 25 per cent low, 3 from 30 to 40 per cent low and 5 from 50 to 60 per cent low.

The lack of correlation between the values for the blood, urine and lens might be explained on the basis of the duration of the vitamin deficiency. The more recent dietary would be reflected in the vitamin C content of the blood and urine, while that of the lens might be decreased owing to a prolonged inadequacy. Accurate dietary histories

TABLE 4.—Data on Group of Sixteen Patients for Whom Records Are Complete

Patient	Vitamin C Content of Lens, Mg. per 100 Gm.	Age	Vitamin C Content of Blood, Mg. per 100 Cc.	Vitamin C Content of Urine, Mg. per 24 Hr. Specimen	Diagnosis
M. O.	10.40	81	1.03	6	Cataract; diabetes; blind for several years
C. D.	10.50	43	0.94	7	Posterior polar cataract, complicated
L. D.	12.50	66	0.64	13	Retinitis pigmentosa; bilateral senile cataract
G. H.	12.70	68	1.10*	22*	Subcapsular cataract
H. S.	13.20	26	0.95	12	Gonococci vaginitis; posterior polar cataract
M. C.	17.80	73	0.89	10	Hypertensive cardiac disease
F. C.	19.50	57	0.89	15	Hypertensive cardiac disease; senile mature cataract
B. G.	20.50	57	1.14	11	Bilateral cataract, cortical and immature
T. D.	22.20	39	1.02	4	Traumatic cataract
J. L.	22.20	72	0.79	5	Arteriosclerotic cardiac disease; senile mature cataract; hypertension
E. G.	23.15	59	1.14	7	Intra-ocular hemorrhage; senile mature cataract
A. L.	24.00	66	0.61	3	Glaucoma; old iritis
J. G.	25.50	76	1.00	2	Glaucoma at 69 years; cortical cataract
W. H.	29.30*	66	0.84	4	Mature senile cataract
P. H.	30.20*	66	1.35*	12	Mature senile cataract, 8 years standing
L. J.	42.50	53	1.07	11	Glaucoma; dislocated lens

* The values are within the expected normal range. We regret that to date we have not been able to obtain a normal lens for analysis but must accept the value of 30 mg. (footnotes 3 and 4).

TABLE 5.—Correlation of Average Values for Vitamin C in the Lens with Those in the Blood and Urine and with Age

Lens, mg. per 100 Gm.....	10-15	16-20	21-25	26-30	31-36
Average age, years.....	57 (5)*	62 (3)	62 (5)	62 (2)	53
Blood, mg. per 100 cc.....	0.94 (5)	0.97 (3)	0.91 (5)	1.10 (2)	1.07 (1)
Urine, mg. per 24 hr. specimen	12 (5)	12 (3)	4 (5)	8 (2)	11 (1)

* The numbers of patients included in the average are given in the parentheses.

TABLE 6.—Correlation of Average Values for Vitamin C in the Urine with Those in the Blood and with Age

Urine, mg. per 24 hr. specimen	Under 5 mg.	6-10	11-15	16-20	21-25
Age, years.....	64 (5)*	64 (4)	54 (6)	..... *	68 (1)
Blood, mg. per 100 cc.....	0.85 (5)	1.01 (4)	1.01 (6)	.....	1.10 (1)

* The numbers of patients included in the average are given in the parentheses.

are difficult to obtain and not too satisfactory. As to a possible correlation between the cevitic acid content and the cause of cataract, none is found. Analysis of the mature cataract of eight years' standing which was removed from subject P. H. and determination of the vitamin C

content of the blood indicated that both were in the normal average range. The vitamin C content of the urine was slightly lower than the average, but, as has been pointed out, the immediate preceding diet is a definite factor in determining the level. The mature cataract of E. G. was higher in vitamin content than the traumatic cataract of T. D. or the immature cataract of B. G. A larger series of patients might, of course, alter the data.

Since the average of the values for the vitamin C content of the urine was so definitely low, the question arose as to whether old age in itself with its almost universal dietary change might not, at least in part, account for the low levels.

With the permission of Dr. Eric Green and the active cooperation of Mr. George K. Anderson, studies were made on the urine of twelve patients in the Monroe County Home. Subjects were carefully selected as to age to be controls for the group of patients with ocular conditions; that is, cataractous changes could not be detected in any of the patients. The average urinary excretion of cevitamic acid for this group was 11.71 mg. in a twenty-four hour specimen, obtained under basal conditions, with extreme values of from 5.91 to 18.20 mg. As in our subjects from the hospital, the response to a daily dose of 200 mg. of vitamin C was followed. The response to the first 200 mg. of the vitamin raised the output for the group to an average of 13.07 mg. The large retention of the vitamin (intake minus urinary content) indicated a state of tissue unsaturation. A dietary survey of previous intake indicated that the ingestion of vitamin C was low. The average vitamin C content of the urine for the entire group of patients with ocular conditions (including those on whom complete data were not obtained) was 10.60 mg. in a twenty-four hour specimen, obtained under basal conditions, with extreme values of from 2 to 24 mg. The response, to the first 200 mg. of vitamin C in this group was 13 mg. The two groups, therefore, were not unlike in tissue saturation, as evidenced by initial level and response. The patients with ocular conditions were not more depleted of their stores of vitamin C than the patients from the county home. The urinary excretion in response to successive constant doses of vitamin C continued approximately the same over a period of a week for both groups. From these two sets of data it could not be seen "that in a cataractous subject much larger quantities of vitamin C are required to raise the value in the blood plasma than in a normal person" (Bellows⁵). However, the values for persons in the same age groups whose normal diet was consistently higher in vitamin C than was that of the patients at the county home might be the same as those reported by Bellows. It is hoped to obtain some patients in the same age group who have orthopedic conditions and whose dietary

intake can be controlled for a long period to ascertain whether or not the normal response to vitamin C is lower in the elderly person than it is in the younger person irrespective of ocular abnormalities.

SUMMARY

While from our data there is a definitely decreased amount of cevitic acid in the cataractous lens, from a normal of 30 mg. to 10 mg. per hundred grams of lens tissue, and while there is a definitely lowered vitamin content in the urine, the values for the blood are in general within a low normal range.

No correlation could be found between age and the content of vitamin C in the lens, urine and blood, except the blood-urine relation, which is physiologic, and a possible age-blood correlation.

No correlation was found between the type of abnormality in the lens and the level of vitamin C.

Dietary histories in general indicate a lowered intake of foods rich in vitamin C in the old age group, probably due to several factors:

(a) The comparatively recent realization of the need of vitamin C and, for its adequate intake, the inclusion of citrus fruits or uncooked fruits and vegetables in the diet. The food habits of the older generation, which are so frequently continued through life, did not include these foods.

(b) The decreased use of fresh fruits and vegetables due to economic stress. Many of our patients are in the "low income" group.

(c) The voluntary decrease of acid foods or foods hard to chew or of high roughage content which so commonly occurs with advancing years.

To quote Bellows:⁵ "The absence or diminution of cevitic acid in the aqueous and in the lens of the cataractous eyes brings forth the question of the relationship of vitamin C and cataract. Is the loss of vitamin C secondary to the changes in the lens, as Bietti has suggested, or does its diminution or deficiency precede the development of opacities in the lens?" Though adequate diet cannot fail to be more effective in the preservation of normal function than one deficient in any respect and the inclusion of sufficient amounts of food rich in vitamin C advantageous, and in spite of the contrary evidence of other investigators, one is forced to conclude from the data here presented that the low content of vitamin C in the lens may be a result of cataractous changes rather than the underlying cause and that tissue saturation as measured by the vitamin C content of the urine and blood suggests that it is probably not responsible for the onset of the cataract.

Since this paper was accepted for publication it has been the privilege of one of us to read and discuss the manuscript of a paper on the use of the Evelyn photoelectric colorimeter as a means of measuring the reducing substances in urine. Dr. Evelyn's excellent discussion indicates that undoubtedly values for cevitamic acid as heretofore determined are too high. In urine certainly other reducing substances besides cevitamic acid may enter into the reaction and increase the titration value.

CAUSTIC BURNS OF THE EYE

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There are many cases of partial or complete blindness due to burns of the eye. Cowan and Sinclair,¹ in their recent review of blindness in Pennsylvania, reported 179 cases of blindness due to burns of the eye of different types and only 26 of blindness due to detachment of the retina. Detachment of the retina is being thoroughly investigated. Much progress has also been made in the treatment of burns of the skin. These facts considered, burns of the eye are not receiving the attention they merit. For example, many physicians continue to treat such burns with test tube neutralizing substances, although this method of treating cutaneous burns has been discontinued for some time. There are many differences between cutaneous and ocular tissues, but there are also similarities. Some of the methods used in the treatment of the one may apply in the treatment of the other.

In this paper it is desired (1) to discuss briefly changes that take place when acids and alkalis injure tissues, (2) to refer to treatments of burns of the skin, (3) to report several experimental observations and (4) to suggest certain phases of treatment.

CAUSTIC ACIDS

When an eye is burned by a caustic acid in small amounts, most of the precipitation seems to be completed at once. Theoretically, free acid may remain in the interstitial spaces, deep in the eye and at the margins. The action of this acid might be compared roughly to the action of iodine under a bandage. When there is a large excess of acid, precipitation of proteinate continues longer. Sollmann² stated that the action of concentrated acid consists in withdrawal of water from the tissues, formation of acid albumins and softening but not dissolving of connective tissue and epithelium. Simon³ stated that the nucleoproteins are precipitated. In regard to albumins, Hawk⁴ stated

1. Cowan, A., and Sinclair, S. M.: Causes of Blindness in Pennsylvania from Medical and Social Aspects, J. A. M. A. **107**:757-760 (Sept. 5) 1936.

2. Sollmann, T.: Manual of Pharmacology, Philadelphia, W. B. Saunders Company, 1917, pp. 125, 131 and 137.

3. Simon, C. E.: A Text-Book of Physiological Chemistry, Philadelphia, Lea Brothers & Co., 1904, p. 58.

4. Hawk, P. B.: Practical Physiological Chemistry, ed. 6, Philadelphia. P. Blakiston's Son & Co., 1920, pp. 105 and 452.

that when albumin is heated acid must be added to secure its complete precipitation. Gradle⁵ found that in some cases of hot acid burns of long standing in which opacities developed there was no evidence of previous dissolution of the corneal epithelium. Undissolved epithelium may account in part for the smoothness of the coagulated area. Corneal burns from unheated caustics stain with dyes, however. This indicates that even though the epithelium may not have been dissolved, the continuity has been broken and infiltration has taken place. The insolubility of the acid precipitate probably accounts for the relatively favorable outlook of burns from acid, the insoluble precipitate protecting the cornea from further injury except from acid, which may remain free until it also reacts with adjacent tissue, without burrowing, to form a precipitate.

CAUSTIC ALKALIS

When the caustic is an alkali, the damage is more severe and continues to become progressively worse for some time. In regard to the progressive action, Cross⁶ stated: "Caustic soda burns give no evidence on the first day that they will look much worse on the third day than at the time of injury." Sollmann² said: "The area of necrosis produced by alkalies is very soft and the compounds which alkalies form are very soluble; consequently the alkalies penetrate very deeply and their action continues for several days." Simon³ also called attention to the solubility of certain proteins in alkali solutions, particularly nucleoproteins and nucleins. The solubility of the alkaline compounds probably accounts for the unfavorable outlook following burns from alkalis.

From the foregoing discussion it would not appear favorable to attempt to change acid precipitates or coagulates to alkaline proteinates by adding alkalis. On the other hand, it would appear helpful to change soft alkaline precipitates to insoluble ones by adding acids. This agrees with the results of my experimental study.^{5a}

TANNIC ACID, SILVER NITRATE AND METHYL ROSANILINE

Tannic Acid.—Tannic acid is probably the most widely used agent for treating burns. Its action on the tissues is described in textbooks of pharmacology and, since popularized by Davidson,⁷ in numerous

5. Gradle, H. S.: Battery Burns, J. A. M. A. **79**:1819-1821 (Nov. 25) 1922.

5a. Hubbard, W. B.: Treatment of Caustic Burns of the Eye, Arch. Ophth. **18**:263-266 (Aug.) 1937.

6. Cross, G. H.: Ocular Injuries: Their Treatment, Arch. Ophth. **7**:357-360 (March) 1932.

7. Davidson, E. C.: Tannic Acid in the Treatment of Burns, Surg., Gynec. & Obst. **41**:202-221 (Aug.) 1925.

articles and books. Its use as an astringent in the practice of ophthalmology is described in numerous textbooks, although it is rarely advised in the treatment of burns of the eye. Graves⁸ advised it in a 1 per cent solution for dropping into the eye. For burns of the eye from alkalis Cross⁶ used a 20 per cent solution of glycerite of tannic acid U. S. P. locally on a cotton swab, with excellent results.

Tannic Acid and Silver Nitrate.—Bettman⁹ found that cutaneous burns treated with a 5 per cent solution of tannic acid followed by a 10 per cent solution of silver nitrate had a more favorable action than tannic acid alone.

Methyl Rosaniline and Silver Nitrate.—Branch¹⁰ recently advised treatment of burns of the skin by spraying with a 1 per cent aqueous solution of methyl rosaniline, swabbing of the area after from three to four minutes with a 10 per cent solution of silver nitrate and then after the solution began to dry respraying the entire burned area with the solution of methyl rosaniline five times at intervals of fifteen minutes. He found that the area becomes infected less often than when treated with tannic acid.

EXPERIMENTAL WORK

Along the lines mentioned, several experiments were performed on the eyes of anesthetized rabbits. It was decided (*a*) to observe the effect with the use of tannic acid alone and (*b*) to compare the results with tannic acid, tannic acid and silver nitrate, methyl rosaniline and silver nitrate and one other combination, namely, methyl rosaniline and tannic acid.

(*a*) *Effect of Treatment with Tannic Acid.*—Three drops of a caustic alkali was instilled into one eye and 3 drops of a caustic acid into another. In each eye the injured cornea became opaque immediately, and areas of conjunctiva were also precipitated. No macroscopic break was observed in the coagulated corneas, but when fluorescein was added the injured parts were seen to stain. A similar condition obtained at the end of five hours. A 5 per cent solution of tannic acid was then instilled. The injured moist conjunctival area was immediately covered with a firmer, thicker, drier, yellowish white precipitate, and appeared in a more favorable condition for healing. Clinically, the eyes were much improved the following day and continued to improve. There was no excess moisture, little discharge and no infection during the twenty days of observation. At that time the periphery of each cornea was translucent. Over each pupil there remained a small, superficial, gradually healing ulceration of the cornea.

8. Graves, B., in Berens, C.: *The Eye and Its Diseases*, Philadelphia, W. B. Saunders Company, 1936, p. 499.

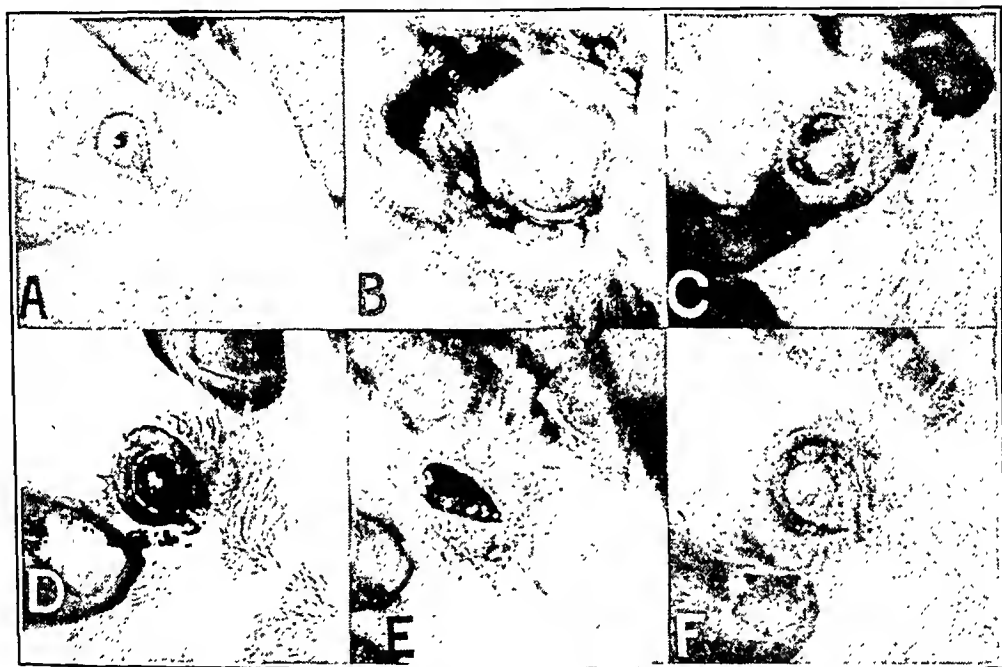
9. Bettman, A. G.: *The Tannic Acid-Silver Nitrate Treatment of Burns*, J. A. M. A. **108**:1490-1494 (May 1) 1937.

10. Branch, H. E.: *Extensive Burns: Treatment with Silver Nitrate and Methyl Rosaniline*, Arch. Surg. **35**:478-485 (Sept.) 1937.

(b) *Effect of Treatment with Tannic Acid, Tannic Acid and Silver Nitrate, Methyl Rosaniline and Silver Nitrate, and Methyl Rosaniline and Tannic Acid.*—The cornea of each rabbit was covered with, and the conjunctival sac was filled with, 11 drops of a 20 per cent sodium hydroxide for exactly ten seconds. The eyes were then irrigated with water. The irrigation completed the treatment of the control rabbit, but the experimental agents were at once instilled freely into the eyes of the others. Treatments with the experimental agents were repeated once the following day.

Control Experiment: After irrigation of the eye, no other treatment was given. There was early sloughing of the conjunctiva. Later rupture of the cornea occurred, with degeneration of the eye on the eighteenth day.

Tannic Acid: When a 5 per cent solution of tannic acid was instilled into the eye the cornea became stained a light yellow. The injured conjunctival elements



A, normal eye of rabbit. Note the transparent cornea, with the iris and the pupil clearly seen, and the normal lids. The nictating membrane is not as prominent as usual. *B*, rabbit's eye one day after a burn from a caustic alkali. No treatment was given. Note the opaque cornea. *C*, rabbit's eye one day after a burn from a caustic alkali. The treatment consisted of the instillation of a 5 per cent solution of tannic acid. Note the whitish gray opaque cornea. *D*, rabbit's eye one day after a burn from a caustic alkali. The treatment consisted of the instillation of a 5 per cent solution of tannic acid followed by the instillation of a 2 per cent solution of silver nitrate. Note the brilliant black stain, especially of the cornea. *E*, rabbit's eye one day after a burn from a caustic alkali. The treatment consisted of the instillation of a 1 per cent aqueous solution of methyl rosaniline followed by the instillation of a 2 per cent solution of silver nitrate and the additional use of methyl rosaniline. Note the purplish black stain, especially of the cornea. *F*, rabbit's eye one day after a burn from a caustic alkali. The treatment consisted of the instillation of a 1 per cent aqueous solution of methyl rosaniline followed by the instillation of a 5 per cent solution of tannic acid and the additional application of methyl rosaniline. Note the purplish stain, especially of the cornea.

were precipitated into a firm yellowish coagulum. However, the following day dissolution of the conjunctival coagulum was beginning, and in spite of the treatment on that day it continued. Every day the conjunctival sac was filled with flocculent or creamy discharge, and necrosis of the deeper layers of the cornea began. The lids were usually swollen shut. On the nineteenth day the eyeball had degenerated through generalized necrosis and rupture of the cornea.

Tannic Acid and Silver Nitrate: Instillation of a 5 per cent solution of tannic acid caused the changes that were described in the preceding experiment. However, when a 2 per cent solution of silver nitrate was added, the injured cornea, nictating membrane and conjunctiva were immediately stained a brilliant black. The eye seemed to progress nicely. The stain of the conjunctiva gradually decreased. There was no evidence of dissolution or infection of the coagulum. The coagulum over the cornea appeared leathery and dry. After nineteen days some sloughing of the conjunctiva and posterior soft tissues had appeared. Most of the cornea was black, although the coagulum was loosening in spots. On the twentieth day a mild orbital abscess developed. On the twenty-fifth day the abscess had subsided. The eyeball was firm and in good condition. Not until the twenty-seventh day did rupture of the necrosed cornea occur.

Methyl Rosaniline and Silver Nitrate: When a 1 per cent solution of methyl rosaniline was instilled into the eye, the membranes were immediately stained a brilliant violet. When a 2 per cent solution of silver nitrate was added the stain took on a blackish tinge. The instillation of silver nitrate was followed by the use of additional methyl rosaniline. The progress was relatively good. At the end of twenty-seven days the cornea had necrosed and ruptured.

Methyl Rosaniline and Tannic Acid: A 1 per cent solution of methyl rosaniline stained the tissues a brilliant violet. No macroscopic change was noted when a 5 per cent solution of tannic acid and additional methyl rosaniline were added. The progress in this eye after twenty-six days was similar to that in the eye treated with methyl rosaniline and silver nitrate, but somewhat better. On the twenty-ninth day the necrosed cornea ruptured.

COMMENT

The further coagulation of the soluble and partly coagulated tissue elements by agents used on them appeared favorable. Besides reacting with the residual caustic and the injured corneal tissue, apparently the tougher, denser precipitate prevented the lids from irritating the underlying parts. Likewise the injured conjunctiva appeared drier and smoother and less angry and less exposed to infection, and therefore adhesions, though seldom seen in these animals, appeared less likely to form. Contracture of the conjunctiva was not prevented. Prevention of infection appeared necessary.

The poorest result in the controlled group was obtained in the untreated rabbit.

Two rabbits treated with tannic acid showed improvement. In the controlled group the coagulum of the third rabbit, also treated with tannic acid, sloughed rapidly. This may have been due in part to an alkaline reaction of the conjunctival sac, to infection and to excess moisture from tearing. It has been noted that protein tannates are

insoluble in an acid medium while they are soluble in an alkaline medium. Antiseptics were not employed in the treatment. The eye of the third rabbit was moist.

Since a 2 per cent solution of silver nitrate produced immediately such a brilliant black reaction and such an extremely tough and tenacious coagulum, a 0.5, or not more than a 1, per cent solution would undoubtedly be sufficiently strong for the eye. However, should a tough coagulum become infected or adhere too long, one might deal with it as with similar cutaneous coagulum.

The reason for the abscess in the eye treated with tannic acid plus silver nitrate is not apparent. The black coagulum may have sealed in any residual caustic or injurious substance in a way not possible on an exposed surface of the skin. However, the condition of the cornea under the black coagulum seemed relatively good, even after the orbital abscess intervened.

Favorable results were obtained with methyl rosaniline and silver nitrate.

Excellent results were obtained with methyl rosaniline and tannic acid.

TREATMENT OF BURNS FROM ALKALIS

Emergency Treatment.—When an eye is burned with a caustic alkali it should be immediately irrigated with a weak acid or water, whichever is available. Even though some time has intervened since the burn, emergency treatment should be performed. The lids should be thoroughly opened, and the fornices reached. Irrigation should be continued until there is no possibility of free alkali remaining. If water is used for irrigation, weak acid should be applied as soon as possible thereafter. I used a 2 per cent solution of acetic acid advantageously. Weak vinegar, weak hydrochloric acid and other acids would probably be as satisfactory. An acid stronger than boric acid, however, seems desirable.

After-Treatment.—This depends somewhat on the degree of injury. A firm coagulum has been found desirable in the beginning at the site of injury. Several agents may be used, and they should reach all burned areas. Further experimental work is necessary. The following suggestions appear of value.

Instillations.—For the milder burns, frequent instillation of mild reagents seems sufficient and will not injure normal tissue. Occasional instillation of both tannic acid and another acid, such as 2 per cent solution of acetic acid, seems indicated until healing is well under way. From 1 to 2 per cent solution of tannic acid is recommended. Tannic acid jelly, 1 per cent, may be used if desired. Infection should be prevented.

In addition to asepsis, infection may be prevented in several ways, and one may use one's individual preference. A 1 per cent aqueous solution of methyl rosaniline may be instilled as an antiseptic before or after the instillation of tannic acid and may influence the coagulum favorably also. Or, as silver nitrate has been found to prevent infections and to act favorably on coagulated tissue after treatment with tannic acid, instillation from time to time of from 0.1 to 0.2 per cent solution of silver nitrate seems of value as a second choice. Excessive use of silver nitrate should be avoided, as it may result in the production of an extremely tenacious coagulum.

As more than one type of treatment has been found useful, the highly recommended tannic acid may be omitted entirely and another method utilized. For example, a 1 per cent aqueous solution of methyl rosaniline may be instilled before and after the aforementioned weak solutions of silver nitrate.

Localized Applications.—In order to secure more rapid and thorough action in the more severe burns, the agents may be used somewhat stronger in the beginning and applied locally to the injured areas, care being taken to prevent irritation of uninjured membranes.

Burns from lime may be treated by continuous heat-removing irrigation, removal of the lime and the aforementioned methods. At the earliest favorable time thereafter, vigorous treatment with neutral ammonium tartrate should be instituted.¹¹

In the treatment of burns of the eye one should be reminded that burns of the skin do better when dry, i. e., in the absence of aqueous solutions, grease and oil.⁷ The relatively dry eyes in the experiments also progressed more favorably. Therefore, although excessive dryness may be undesirable, it is suggested that excess moisture in the eye be avoided, especially during early after-treatment.

General local measures, such as the use of atropine, should be employed according to the indications.

TREATMENT OF BURNS FROM ACID

Emergency Treatment.—The emergency treatment of burns from acids is similar to that of burns from alkalis with the exception that water alone is used in irrigation. Any neutralization with an alkali is to be avoided.

After-Treatment.—As acid does not burrow as alkalis do, the after-treatment of the milder burns need not be so energetic. However, for severe burns, it appears in order to use the same after-treatment as is

11. Barkan, O., and Barkan, H.: Treatment of Lime Burns of the Eye, J. A. M. A. **83**:1567-1569 (Nov. 15) 1924.

used for burns from alkalis should the coagulum appear unhealthy, and to prevent infection.

SUMMARY

For emergency treatment, water and weak acids should be used freely. The use of an alkaline neutralizing fluid should be avoided.

For after-treatment, the use of alkalis should be avoided, especially in the early stages of treatment. Weak acids are of value. Treatment with tannic acid is usually to be preferred. When tannic acid is used, antiseptics should be used in conjunction with it. Methyl rosaniline and silver nitrate answer this purpose.

To those not desiring to use tannic acid, a combination of methyl rosaniline and silver nitrate is recommended.

Agents, such as atropine and compresses, should be used according to the indications.

Clinical Notes

CLINICAL EXPERIMENTS WITH ONE PER CENT SOLUTION OF EPINEPHRINE HYDROCHLORIDE

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Solution of epinephrine hydrochloride in a concentration of 1:1,000 has been used as a vasoconstrictor for the past forty years. In the practice of ophthalmology this preparation is of more or less therapeutic value for its vasoconstrictive action in cases of scleritis, episcleritis, various forms of conjunctivitis, keratitis (including ulcer), iritis, iridocyclitis, prolapse of the iris, glaucoma and pannus and occasionally in cases of a few other ocular conditions. Recently the 1 per cent strength was introduced for oral administration in cases of asthma, and about two and one-half years ago I began some clinical experimental studies with it in the field of ophthalmology, using two different preparations.¹ The two preparations acted equally well, and so far as these experiments were concerned there did not seem to be any difference in the results.

The first phase of the problem concerning the 1 per cent solution consisted in determining whether it was sufficiently safe for general use in the treatment of those same ophthalmologic conditions for which the 0.1 per cent strength was hitherto employed. Even the use of the latter, apparently, was not wholly free from danger, for in this connection Darier² stated: "In ophthalmology, we employ, as a rule, a 1-1000 solution of adrenalin hydrochlorid, a single drop of which is sufficient to produce a very marked therapeutic effect. It is indeed so pronounced that if it is indicated to use the remedy several times a day, weaker solutions, for example 1-5000, must be employed, since large doses of adrenalin may occasion serious complications."

Bearing this in mind, I performed the earliest experiments on the eyes of cats, rabbits and guinea pigs. At first 1 minim (0.06 cc.) of the solution of epinephrine hydrochloride a day was instilled into the animal's eye, the other eye serving as a control. The only effect noted was the marked temporary blanching of the superficial conjunctival vessels and dilatation of the pupil, which came on within a few minutes and lasted for variable periods up to about two hours. The deeper (scleral) vessels did not become ischemic. There seemed to be no systemic

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1. One of these preparations was donated by Park, Davis & Company and the other by the Wilson Laboratories.

2. Darier, A.: *Ocular Therapeutics*, Philadelphia, P. Blakiston's Son & Co., 1910, p. 165.

effects. Next the preparation was used on patients who were absolutely blind and then on those who were virtually sightless. None of these persons experienced any discomfort, either locally (except for a stinging sensation lasting about half a minute) or systemically. After several months of observation on approximately fifty patients, it was definitely decided that there was no danger or ill effect, either local or general, from its use. In not a single instance was there any systemic reaction, and in no case did the ocular condition become aggravated. Since then I have tried the 1 per cent solution locally in the eyes of over 200 patients without a single disturbing reaction. All of them had the preparation for use at home, employing from 1 to 3 minims (0.06 to 0.18 cc.) in each eye daily, in some instances for as much as six months continuously. Most of the patients were seen once a week.

After the harmlessness of using the preparation in this manner was definitely ascertained, it was tried on patients with a large variety of ophthalmologic conditions, particularly those in which marked vasoconstriction might be an important factor in treatment. All told, I have used the 1 per cent solution of epinephrine hydrochloride in the treatment of more than a dozen diseases, including blepharitis, conjunctivitis (acute and chronic), vernal catarrh, granular conjunctivitis, trachoma, keratitis, corneal ulcer, pannus, iritis, iridocyclitis, glaucoma (acute and chronic), dacryocystitis (acute and chronic), cataract, choroiditis and retinitis. In patients suffering from various types of conjunctivitis the use of the 1 per cent solution induced a marked ischemia of the smaller superficial blood vessels. The more marked the hyperemia, the more marked the ensuing pallor. In those with simple conjunctivitis and vernal catarrh the daily instillation of this solution caused an abatement of the symptoms and seemed to clear up the redness, lacrimation and itching more rapidly than other measures in general use. Recurrences were not prevented but were readily checked whenever they occurred.

When the 1 per cent solution of epinephrine hydrochloride was employed in cases of scleritis and episcleritis, the sclera became a pearly, bluish white. The deeper vessels sometimes stood out more prominently as a result of the pallor induced in the more superficial vessels. When no other measures were used, these effects would disappear in a comparatively short time (a matter of an hour or two). However, if shortly after instillation the eye was massaged with a little yellow mercuric oxide ointment for a minute or two, the episcleral congestion cleared up more readily than otherwise. It would seem, therefore, that the 1 per cent solution of epinephrine hydrochloride is a valuable adjuvant in the treatment of scleral conditions.

In cases of keratitis the cloudiness of the cornea did not seem to be affected in any way by the 1 per cent solution, even though it was continued for several months. Nebulas and leucomas remained unchanged. Phlyctenules sometimes seemed to disappear somewhat more rapidly than otherwise. Ulcers of the cornea were not favorably affected so far as shortening or checking the process was concerned. This was to be expected, in view of the fact that the vasoconstriction retarded the healing process. However, when the solution was used for a day or two in the painful stage of the disease, some patients

obtained relief. It has been claimed that a solution of epinephrine hydrochloride has a beneficial action on pannus. I tried the 1 per cent preparation in several cases in which the condition was well marked and followed up the course by means of slit lamp examinations, but I was unable to note any appreciable change for the better. The same may be said for the use of the solution in cases of cataract, retinitis and choroiditis. When the condition was well advanced there was no improvement, even though some of the patients kept up the treatment and were under observation up to nearly two years.

A very favorable action of the 1 per cent solution of epinephrine hydrochloride was noted in persons with iritis and iridocyclitis, particularly in those who had adhesions from previous attacks and in those with a tendency to elevation of the tension. I tried the preparation on patients with iridocyclitis both with and without the use of atropine. When the solution was used alone, mydriasis did not result in all cases: When there was dilatation of the pupil, it came on within from five to ten minutes as a rule and reached its maximum in about a half an hour. It disappeared gradually within from one to two hours. When the solution was combined with atropine, it seemed to intensify the breaking up of synechiae and to shorten the course of the disease. In several cases in which the tension increased after the use of atropine, I discontinued the atropine and had the patients continue to use the solution of epinephrine hydrochloride without discomfort. Likewise, to break up adhesions, I found it advantageous to alternate the atropine and the solution of epinephrine hydrochloride a number of times. Fuchs stated that epinephrine promotes absorption of the atropine.

In cases of glaucoma, especially acute exacerbations of the chronic variety, the 1 per cent solution of epinephrine hydrochloride usually, though not always, brought about a marked and almost immediate reduction in tension. Sometimes the drop was as much as 20 mm. of mercury as measured by the Schiötz tonometer. The lowering of the tension, however, was not sustained as a rule, unless pilocarpine or physostigmine was used in conjunction with the epinephrine. Unless these preparations were combined, the action was transitory, even though several drops were instilled every two hours. Nevertheless, there was often advantage in a prompt relief from pain. As previously stated, in some cases of glaucoma no appreciable reduction in tension was obtained, even when the solution was employed regularly every four hours for a number of days.

The most dramatic action of the solution was obtained in cases of chronic suppurative dacryocystitis in which there was an acute flare-up. Within a day or two after the introduction of the solution there was a gradual but definite diminution of the inflammation, swelling and pain. This continued until the entire process had subsided, which took about one week. In several cases of this type the condition cleared up without operation. In cases of ordinary epiphora, however, no improvement occurred with this therapy.

Another condition in which the 1 per cent solution holds promise of favorable results is progressive myopia, especially in young children. In some instances the increasing myopia appeared to be arrested. It is still too early, however, to state whether the results are permanent. Nor is it possible as yet to say how long the medication must be kept

up after the myopia has become stationary. On the other hand, there were a number of cases in which there was no improvement.

Among the patients under observation were 2 with congenital nystagmus. These patients were using the 1 per cent solution of epinephrine hydrochloride for other conditions, but after a number of months it was noted several times that the nystagmus decreased. Whether this was a pure coincidence or not, I am not prepared to state. Unfortunately both patients were lost from observation, one after four months and the other after seven months.

REPORT OF CASES

CASE 1.—M. W., a housewife, aged 40, was seen on Dec. 1, 1936, with the complaint that nine weeks previously she had lost the sight of the left eye. Since then the eye had been a little red and moderately painful. According to her history, vision in the left eye had been poor for many years, during which time the eye frequently became inflamed and painful. Vision on the date of admission to the hospital was 20/20—3 in the right eye, perception of light in the left eye. Examination of the left eye showed an irregular pupil with numerous deposits on Descemet's membrane and on the anterior capsule of the lens. The anterior chamber was normal, and there was no increase of intraocular tension. The iris was discolored, and the markings were indistinct. The details of the fundus could not be visualized because of opacities of the vitreous. There were numerous synechiae which could not be broken away completely with atropine. The accessory nasal sinuses were clear. There were numerous decayed teeth, some of which were loose. The patient said she had had repeated attacks of pains in the joints.

A diagnosis of iridocyclitis was made.

The teeth were treated by a dental surgeon; several had to be extracted, and the rest were cleaned up generally. Large doses of salicylates were prescribed. Locally, atropine, hot applications and a patch over the eye were employed. The eye gradually became less painful and less inflamed, but the pupil was still irregular because of adhesions. For the purpose of breaking up the synechiae, I employed the 1 per cent solution of epinephrine hydrochloride, using 1 minim every four hours for five days. It had little effect. The tension remained normal throughout. By this time the pupil had begun to get smaller, and I employed both the solution and the atropine. Most of the adhesions broke away after four or five days. The eye gradually became white again.

In this case it is difficult to determine whether the solution of epinephrine hydrochloride was instrumental in breaking up the adhesions, as I have found that the same type of result has been obtained without it in other cases.

CASE 2.—Mrs. R. De A., a housewife, aged 48, was seen on March 14, 1936, with an acute exacerbation of chronic dacryocystitis. The history was as follows: For several years the patient suffered from excessive tearing. About six months prior to the onset of the present condition, there was pus on pressure at the inner canthus of the affected eye. The pain, swelling and inflammation developed a week before the patient presented herself for treatment.

Physical examination disclosed a brawny, tender swelling. No fluctuation was present. Hot antiseptic applications and astringents were employed for another five or six days. The mass softened, and incision and drainage were advised, but the patient refused surgical intervention. I then began using the 1 per cent solution of epinephrine hydrochloride, 1 minim every four hours. There was an immediate

response. Within two days the swelling and inflammation subsided considerably, and at the end of another week they were gone completely.

I have since used the solution in similar cases with equally good results.

CASE 3.—M. B., a housewife, aged 57, was first seen Jan. 25, 1936, with the complaint of gradual impairment of eyesight for the past three or four years. During all that time she had no pain, but about one week before the present examination she began to have headaches, mainly over the right eye. Vision was 20/200 in the right eye and 20/70—1 in the left eye. The pupils were moderately dilated, the right being slightly larger than the left. The right cornea was "steamy." The anterior chamber was shallow. The lens, fundus and media were clear. There was moderate cupping of the disk. Tension in the right eye was 70 mm. of mercury (Schiotz) and in the left eye 42 mm. In the course of one week, with the use of a 2 per cent solution of pilocarpine hydrochloride, the tension in the right eye dropped to 40 mm., and the pain subsided. On June 9, the patient was seen again because of another attack, despite the fact that she had been using the pilocarpine regularly (at least, so she said). This time the tension in the right eye was 76 mm. of mercury (Schiotz). For several days the pressure remained elevated in spite of the use of pilocarpine. On June 13 it was still 65 mm. I then used the 1 per cent solution of epinephrine hydrochloride, 1 minim every hour. After two hours the pressure dropped to 48 mm. I had the patient continue the use of the solution of epinephrine hydrochloride at home every four hours. When she returned after two days the tension was down to 40 mm., but in a couple of days it was again up to 50 mm. I then had her use physostigmine, together with the solution of epinephrine hydrochloride and the tension dropped and hovered between 38 and 40 mm. for the next few weeks.

In this case, as in others of this type, I found that the 1 per cent solution of epinephrine hydrochloride brought the tension down rather quickly but that it did not keep it down unless it was employed in conjunction with other miotics, such as pilocarpine and physostigmine.

CASE 4.—L. S., a schoolgirl aged 14 years, was seen on Oct. 2, 1931, for refraction. She had been wearing glasses for the past two and a half years. Vision was 10/200 in each eye. Refraction under atropine disclosed bilateral myopia of 5 diopters. The lenses she was wearing at the time were —4.00 D., which gave her vision of 20/30 in each eye. With a full correction, vision was 20/20. I examined the girl at least once every year since her initial visit. Her vision progressively grew worse, and she required a greater minus correction to bring it to 20/20. There was no pathologic condition in the fundi. On Dec. 26, 1936, the vision in each eye was 3/200, with a —8.00 D. lens for the right eye and a —8.25 D. lens for the left eye, vision was 20/20—. I then had her use the 1 per cent solution of epinephrine hydrochloride. For the first three months 1 minim was instilled into each eye every night. Then the dose was increased to 1 minim three times a day. During each month the solution was omitted for a period of one week. The acuity of vision with the correction gradually improved, so that on Nov. 1, 1937, it was 20/15—2 in each eye. Without correction, the vision was 3/200, as before.

I have used the 1 per cent solution of epinephrine hydrochloride in about twenty-five cases of this type. In the vast majority, the acuity of vision with full correction improved. In a few instances I succeeded

in satisfactorily reducing the strength of the minus correction. For the time being at least, the progress of the myopia has been checked in some of these cases. Further observation over a period of several years will be required before it is possible to evaluate more definitely the use of this preparation in the treatment of progressive myopia.

COMMENT

While the foregoing experimental studies were in progress, other workers have reported their experiences with the concentrated solution of epinephrine hydrochloride. Thus Barkan and Maisler³ reported its successful use in the treatment of glaucoma secondary to uveitis. Previously Green⁴ and Gradle⁵ obtained highly satisfactory results in cases of glaucoma. My own results in these conditions have not been as gratifying, but the matter deserves further study.

3. Barkan, O., and Maisler, S.: Adrenalin Chloride 1:100 in Ophthalmology, *Am. J. Ophth.* 20:504 (May) 1937.

4. Green, J.: Two Per Cent Epinephrine Solutions as Substitutes for Laevo-Glaucosan, *Arch. Ophthl.* 5:350 (March) 1931.

5. Gradle, H. S.: Use of Epinephrin in Ocular Hypertension, *J. A. M. A.* 84:675 (Feb. 28) 1925.

AN IMPROVED TRIAL FRAME AND TEMPLES

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In the trial frame presented here the old time bridge is replaced by a nose grip similar to that on modern spectacle frames. The advantages of this type of bridge over the other are as follows:

1. It grips the nose on each side, thereby distributing its weight equally on the two sides rather than letting it all rest on the dorsum of the nose.

2. Once the bridge is adjusted, it cannot slip or slide.

In the case of a straight, nearly vertical nose or a deep saddle nose, the old type of bridge could hardly be kept in position unless the frame was held tightly behind the ears and at the root of the nose, which usually led to pain, so that the frame would have to be released. The new grip eliminates this difficulty. It is more convenient to put on the patient's face and it is more easily worn. Particularly is this problem of maintaining the trial frame in position encountered when children are being examined. With the new type of grip the frame rests on the nose of the child as securely as on that of the adult.

The temples on the trial frames that I have seen and used have all been too long to fit children, and even adults whose faces and heads were small. The temple shown here can be contracted enough to fit a child as comfortably and snugly as it fits an adult.

I may add that I have used a frame with this type of nose piece for the last two years exclusively and with such success that I should not want to go back to the older kind of trial frame.

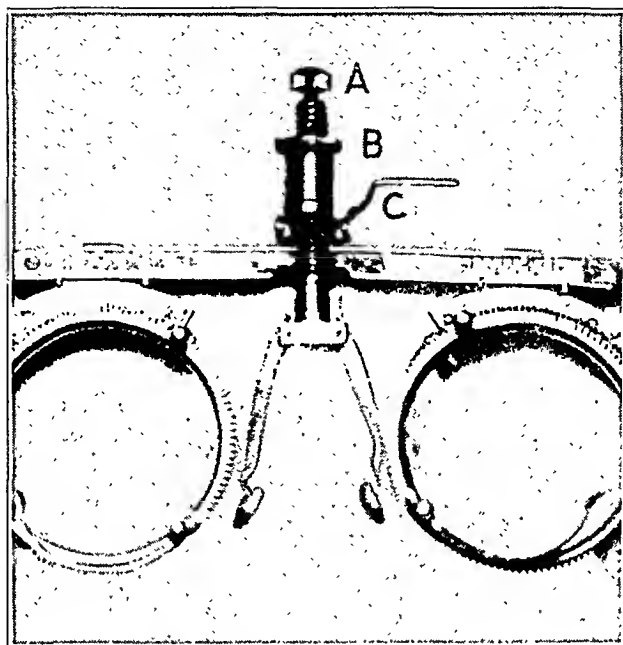


Fig. 1.—Improved trial frame. *A* indicates the knob controlling the spread of the nose pads; *B*, the screw controlling the vertical position of the nose pads, and *C*, the handle controlling their anteroposterior position.

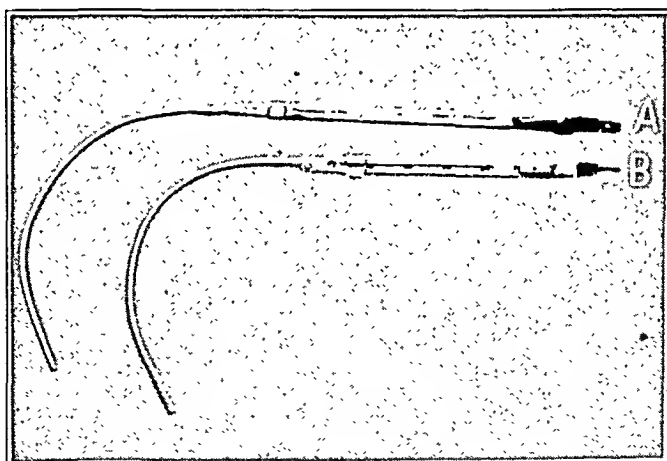


Fig. 2.—Old and new type of temple. *A* shows the shortest length of the old type of temple, and *B*, the shortest length of the new type, which can be extended longer than the old model.

A NEW MODEL GONIOSCOPE

JOHN M. McLEAN, M.D., AND ALBERT GOEBEL, BALTIMORE

This report contains a brief description of an instrument for examining the anterior iridocorneal angle. The instrument combines the advantages of several of the methods now in use and attempts to obviate some of their less desirable features.

Troncoso's¹ gonioscope has two outstanding advantages: It is conveniently portable, and it is so constructed that the entire angle may be readily examined. It gives, however, only relatively low magnification and has the definite disadvantages inherent in monocular visualization of a three-dimensional structure. Koeppé's² method of studying the angle gives the examiner binocular vision, but it has been generally discarded because it is rather awkward and restricts the examination to limited portions of the angle. Barkan and his co-workers³ have described a method for mounting the corneal microscope and slit lamp so that a satisfactory binocular view of most of the angle is obtained. While this arrangement is a decided improvement, it seems a bit cumbersome, and by virtue of permanent suspension from the ceiling, the instrument is not portable. Both Bruce⁴ and Castroviejo⁵ have advocated use of the corneal microscope held in the examiner's hand. This method is satisfactory for a general survey of the angle. As Bruce suggests, it is useful in searching for foreign bodies, but the microscope lacks the firm, steady support necessary for prolonged study or for the use of the higher magnifications.

It seemed, therefore, desirable to construct a gonioscope with the following features: binocular vision, different magnifications, simple and convenient exploration of the angle in its entire circumference and sufficient steadiness for a careful detailed examination, yet sufficient portability to be transferred from the office to the dispensary, ward or operating room. To this end, the following instrument was constructed (fig. 1).

A stand of heavy pipe stock is mounted on a wide four-legged base (*a*) with swivel casters. The upper part of the stand is counterweighted and can be raised or lowered to any desired position (*b*). From this portion a horizontal arm (*c*), composed of two parallel members mounted on a pivoted brake drum, carries the examining and illuminating parts. The binocular head of the microscope (*d*), which may be taken from a slit lamp, is suspended, together with its rack and pinion for focusing, under the end of this horizontal arm. The complete head is mounted on an axle (*e*), so that it may be set at the various necessary angles.

From the Wilmer Ophthalmological Institute of the Johns Hopkins Hospital and University.

1. Troncoso, M. U.: *Am. J. Ophth.* **8**:433, 1925.
2. Koeppé, L.: *Ztschr. f. Augenh.* **40**:138, 1918.
3. Barkan, O.; Boyle, S. F., and Maisler, S.: *Am. J. Ophth.* **19**:209, 1936.
4. Bruce, G. M.: *Visualization of Foreign Bodies in the Iridocorneal Angle*, *Arch. Ophth.* **10**:615 (Nov.) 1933.
5. Castroviejo, R.: *Am. J. Ophth.* **19**:786, 1936.

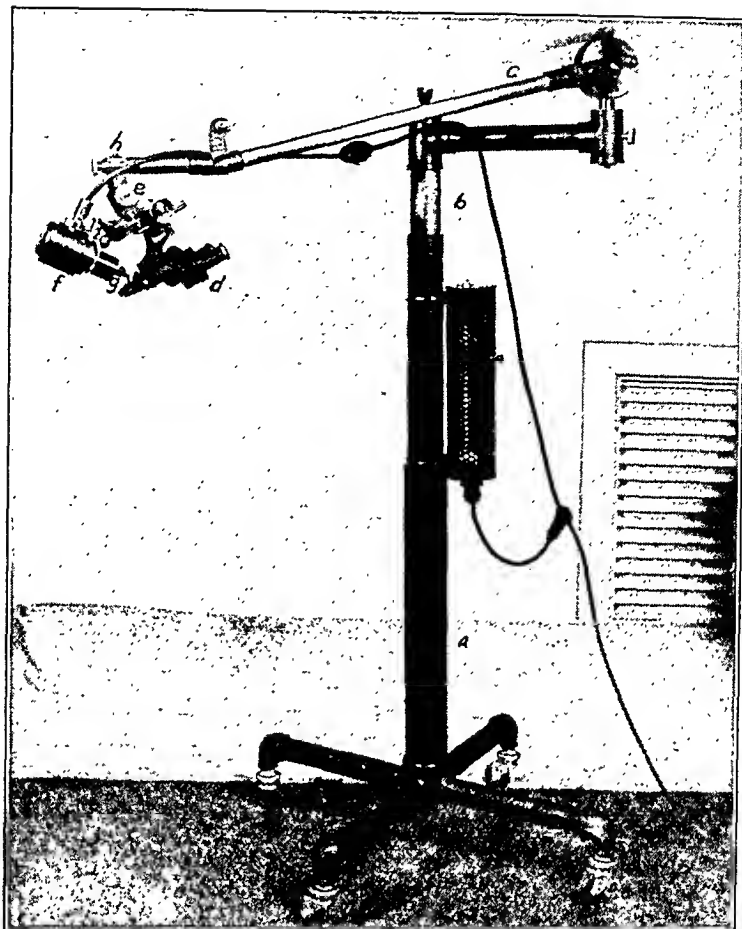


Fig. 1.—A new model gonioscope.

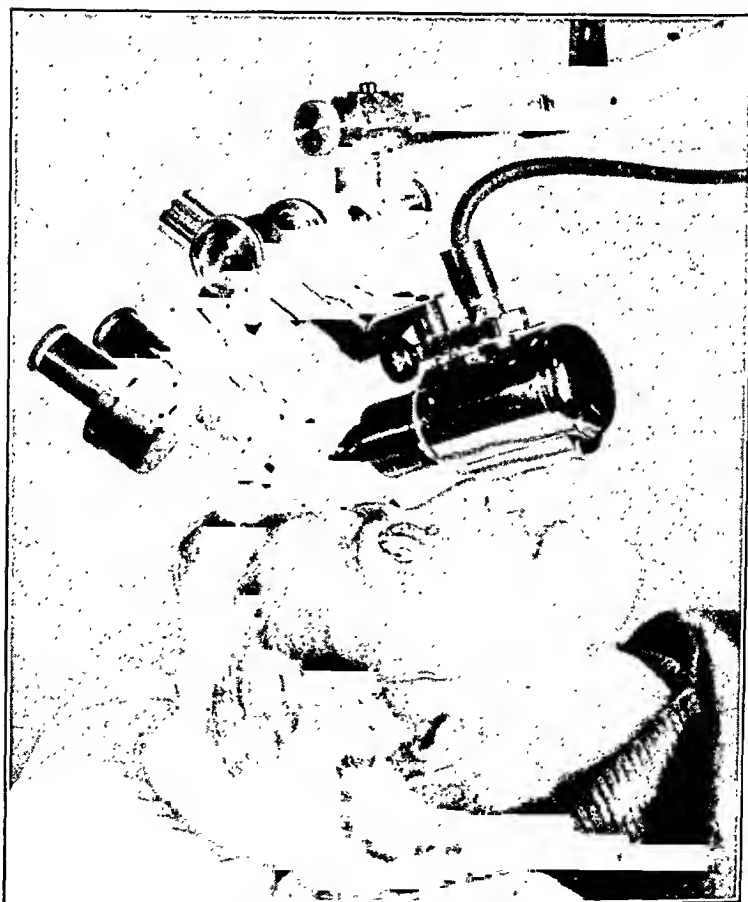


Fig. 2.—The patient under the instrument with the gonioscopic glass in place.

Illumination is supplied by a "hammer" lamp (*f*) mounted on an extension of the base of the microscope, so that they both move together and maintain the same relative positions. A mirror (*g*) on a universal joint and adjustable sleeve reflects the light into the eye. The entire illuminating and viewing unit is suspended by a pivot (*h*), which allows free rotation but can be locked by a set screw.

The complete instrument may be wheeled from place to place but maintains a rigid stability. Its various adjustments allow the head to be raised or lowered and swung over the patient's eye in almost any location. Examination is always conducted with the patient lying down. The usual gonioscopic glass (fig. 2) is inserted after anesthetization with pontocaine hydrochloride, and the glass is filled with physiologic solution of sodium chloride. The pivot (*h*) is centered over the eye, so that once the light and microscope are brought into focus little, if any, readjustment is necessary for examination of the entire angle, as the instrument is rotated about this point. The inverted position of the microscope and light keeps them out of range of the nose, the brow and other obstructions. Adjustment of the angle of illumination and steady binocular magnification of variable degree give a satisfactory detailed view of the angle of the anterior chamber with good depth perception.

Ophthalmologic Review

EDITED BY DR. FRANCIS HEED ADLER

PATHOGENESIS OF CHRONIC SIMPLE GLAUCOMA

A NEW CONCEPT OF THE MAINTENANCE OF THE NORMAL
INTRAOCULAR PRESSURE

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In the literature on the mechanism of glaucoma one finds that all the theories proposed have as their basis of explanation a disturbance or change in some particular structure of the eye. These theories actually fail to explain the mechanism of chronic simple glaucoma. In the observation of patients with this disease the impression is inescapable that in its clinical aspects chronic simple glaucoma presents striking analogies to such diseases as essential arterial hypertension and diabetes. The common denominator of these diseases is, as I shall show later, a disturbance in the regulation of physiologic function. On the basis of these analogies it seemed logical to attempt to explain the mechanism of chronic simple glaucoma as primarily a disturbance in the regulation of the normal intraocular pressure. It is the purpose of this communication to present the new concept. In the following discussion I shall, first, review briefly the theories of glaucoma; second, discuss the prevailing understanding of the normal intraocular pressure and show the inadequacy of the theory of a hydrostatic-osmotic equilibrium; third, present my own conception of the maintenance of the normal intraocular pressure, and, fourth, present a new concept of the pathogenesis of chronic simple glaucoma.

Although much of what I have to say is theoretic and conjectural, these theories, I believe, present a logical sequence which helps in the understanding of this disease.

THEORIES OF THE MECHANISM OF GLAUCOMA

The theories which attempt to explain the mechanism of glaucoma have been reviewed within recent years by Gifford,¹ Thiel² and Peters,³

1. Gifford, S. R.: The Pathogenesis of Glaucoma, *Arch. Ophth.* **3**:88 (Jan.) 1930.

2. Thiel, R.: Die Physiologie und Pathologie des Augendruckes; Glaukom, in Schick, F., and Brückner, A.: *Kurzes Handbuch der Ophthalmologie*, Berlin, Julius Springer, 1931, vol. 4, pp. 666 and 700.

3. Peters, A.: *Das Glaukom*, ed. 3, Berlin, Julius Springer, 1930.

and their publications contain extensive bibliographies. For my purpose I shall briefly review the important theories.

Since the intraocular pressure is dependent on the tension exerted on the scleral coat by the intraocular structures, most of these structures have been made the basis on which theories of mechanism of glaucoma have been built. They include the sclera, the iridocorneal angle, the ciliary body, the vitreous and the choroid. These theories may be classified as follows: (1) retention theories, based on a hindrance to the elimination of the aqueous; (2) a theory based on an increase in the production of aqueous, and (3) a theory based on an increase in the volume of one or more of the intraocular structures.

RETENTION THEORIES

Retention Due to a Change in the Sclera.—According to this theory, the sclera loses its elasticity and shrinks, and by its shrinkage hinders the proper outflow of the aqueous. The loss of elasticity is due either to a senile change or to the sequence of inflammatory changes.

Retention Due to Blocking of the Drainage of the Aqueous at the Iridocorneal Angle.—Blocking of the angle followed by an increase in intraocular pressure has been produced experimentally and is frequently the cause of secondary glaucoma. In cases of chronic simple glaucoma blocking has been assumed to be due (*a*) to pressure of the iris against the angle, the iris being pushed forward either by a large lens or by a hypertrophied ciliary body or the whole lens-iris diaphragm being pushed forward from behind; (*b*) to inflammatory changes in the anterior segment of the eye followed by adhesions between the iris and the cornea; (*c*) to the deposits of pigment in the pectinate ligament; (*d*) to primary sclerosis of the pectinate ligament; (*e*) to changes in the endothelium lining Schlemm's canal; (*f*) to an inability of the angle to open widely, and (*g*) to a combination of several of these factors.

In objecting to these theories based on the blocking of the iridocorneal angle it may be said that all the changes found in the angle in cases of chronic simple glaucoma can be viewed as the consequence of glaucomatous tension. The angle is frequently found to be open and is always open in the early stages. Troncoso,⁴ who recently reviewed the subject, examined 34 eyes with simple glaucoma and found the angle open in 19, partly closed in 13 and closed in 2. He concluded that in cases of simple glaucoma peripheral synechia is the result and not the cause of the increase in pressure. Inflammatory changes have not been found in the angle in the early stages of simple glaucoma, and

4. Troncoso, M. U.: Closure of the Angle of the Anterior Chamber in Glaucoma, *Arch. Ophth.* 14:557 (Oct.) 1935.

the deposit of pigment is a senile change frequently found in the irido-corneal angle in nonglaucomatous eyes. Pigment in the angle is more frequently found in the Japanese than in members of the white race, although glaucoma is not more frequent in Japan.

Retention Due to Blocking of the Drainage of the Aqueous in the Iris as a Result of a Deposit of Pigment or of Degenerative Changes.—A deposit of pigment in the iris has the same significance as that in the angle, and degenerative changes may well be considered as secondary to the increase in tension.

THEORY BASED ON AN INCREASE IN THE PRODUCTION OF AQUEOUS

An increase in the production of aqueous has been assumed to be due to disturbances in innervation and to inflammatory and degenerative causes. Aside from the fact that no such changes have been found in the early stages of glaucoma, such a theory does not explain why the removal does not keep pace with the increased production.

THEORY BASED ON AN INCREASE IN THE VOLUME OF THE INTRA- OCULAR STRUCTURES

The Vitreous.—The vitreous, behaving as a colloid, swells when brought to an acid reaction. It has been assumed that there occurs in glaucoma a change in the reaction of the vitreous toward the acid side, causing it to swell and thus increasing the intraocular pressure. Investigation has shown that normally the p_H of the vitreous is around 7.5 to 7.6, and any change in the reaction toward the acid side causes a diminution in the volume of the vitreous until the isoelectric point, which is 4.2, is reached.

The contrary has been assumed by others, that is, that the vitreous becomes more alkaline and swells. Critical investigation seems to show that the vitreous in the living eye is at its maximum turgescence.

Other theories based on an increase of the fluid content of the vitreous or on the difficulty of fluid leaving the vitreous seem to have little in support.

The Choroid.—The choroid is a highly vascular membrane which can easily change its thickness by varying its blood content. A number of theories as to the cause of glaucoma have been built on this fact, as follows:

(a) Obstruction of the vortex veins occurs owing to kinking of the veins at the sinus or to endophlebitic or sclerotic processes in the veins. The last factor has been especially emphasized by Magitot and

Bailliant⁵ and has been fortified by the fact that when the vortex veins are tied experimentally the intraocular pressure quickly rises. Friedenwald,⁶ who repeated Koster's experiments of ligating the vortex veins, found that the increase in pressure and the other changes were only transitory and that in a short time the pressure returned to normal.

(b) A relaxation of the vasomotor mechanism causes a relaxation of the uveal vessels and an increase in the blood content of the eye. This is the view of Hamburger,⁷ who bases his treatment of glaucoma with epinephrine and epinephrine substitutes on it.

An increased tonicity of the general sympathetic nervous system as well as a disturbance in the function of the sympathetic nerve fibers in the eye has been assumed by others to be the cause of glaucoma. While relaxation or dysfunction of the sympathetic nervous system may be a factor in acute congestive glaucoma, there does not seem to be any proof that it plays any role in the causation of chronic simple glaucoma.

Thiel,² in reviewing the theories concerning the mechanism of glaucoma, came to the conclusion that there are a number of local and general factors which play a role in the etiology of glaucoma, including disturbances in the regulation of the intraocular vascular apparatus which cause changes in the circulation and in the exchange of fluid between blood and tissues. Since the vessels are under the control of the sympathetic nervous system, there is probably a close relation to the endocrine and the vegetative nervous systems. Thiel concluded that essentially the pathogenesis of primary glaucoma is still unknown.

SUMMARY

On reviewing all these theories, I find that each and all attempt to explain the production of glaucoma on the basis of a disturbance or change in some individual structure of the eye or in a combination of several of them. A close study of these theories brings the conviction that they are insufficient to explain the pathogenesis of glaucoma. Some authors, like Thiel, hint at a disturbance in regulation, at a multiplicity of factors and at a relation to the endocrine and sympathetic nervous systems in a vague sort of way. However, no definite theory which is based on a disturbance in regulation has so far been advanced.

5. Magitot, A., and Bailliant, P.: *The Circulatory Regime of Glaucoma*, *Am. J. Ophth.* 8:761, 1925.

6. Friedenwald, J. S.: *The Pathogenesis of Acute Glaucoma*, *Arch. Ophth.* 3:560 (May) 1930.

7. Hamburger, C.: *Ueber die Ernährung des Auges*, Leipzig, G. Thieme, 1914.

NORMAL INTRAOCULAR PRESSURE

A complete review of the physiology of the intraocular fluids and of the normal intraocular pressure is given by Duke-Elder⁸ in the first volume of his "Textbook of Ophthalmology" and by Adler.⁹

The normal intraocular pressure ranges from about 18 to 25 mm. of mercury. During the twenty-four hours of the day there are slight variations of about 2 or 3 mm.; the pressure is highest in the early morning and lowest in the late afternoon. In the normal person with no tendency to glaucoma the normal intraocular pressure persists throughout life. How is this pressure maintained?

The eye is a globe made up of a slightly distensible coat and containing solid, semisolid and liquid structures which occupy a limited space. The pressure in such a globe is produced by the elasticity of the coat and by the volume of its contents. The slightly distensible coat is made up of the cornea and the sclera. The contents consist of a solid lens, uvea and retina, a semisolid vitreous and a liquid blood and aqueous. The distensibility of the cornea and sclera is extremely slight. As given by Duke-Elder from Koster's figures, the increase in the volume of the eye is only 0.007 per cent of the original when the internal pressure is raised from 13 to 70 mm. of mercury.¹⁰

The influence of the solid and semisolid contents on the intraocular pressure can be seen when the eye is excised or exsanguinated (Duke-Elder). The intraocular pressure then sinks to 10 mm. of mercury and maintains this level until disintegration of the tissues sets in, when it sinks to zero. The residual tension of 10 mm. must therefore be maintained by the slightly elastic sclera and cornea compressing the solid and semisolid contents. The difference in tension between the residual 10 mm. and the normal 18 to 25 mm. of mercury must therefore be maintained by the blood and by the aqueous, which is a derivative of the blood. I may best quote Duke-Elder: ¹¹

On allowing the flow of blood to resume in the exsanguinated eye, as, for example, on ligating and then freeing the carotid, or on exsanguination and subsequent perfusion, the vascular channels are refilled, and, since the external coat is only feebly distensible, the entrance of additional fluid involves a rise of pressure. In this way the feeding arteries pile up pressure, and the intraocular pressure therefore rises until a point is reached when an adequate circulation is maintained. At this point the pressure equilibrium is established. . . .

By an adequate circulation is meant a normal inflow and outflow of blood and a normal rate of production and elimination of aqueous.

8. Duke-Elder, W. S.: Text-Book of Ophthalmology, London, Henry Kimpton, 1932, vol. 1, sect. 4, chaps. 9, 10 and 11.

9. Adler, F. H.: Clinical Physiology of the Eye, New York, The Macmillan Company, 1933, chaps. 13 and 14.

10. Duke-Elder,⁸ p. 496.

11. Duke-Elder,⁸ p. 495.

The blood and the aqueous are thus the two important structures in the maintenance of the intraocular pressure. The ultimate height of pressure in the eye is determined according to Duke-Elder, and his opinion seems to represent that of most of the investigators on this subject, by two mechanisms, each representing certain physical forces:

1. A hydrostatic-osmotic equilibrium. To continue the quotation from Duke-Elder:¹¹

. . . the ultimate height of the pressure in the chambers of the eye is determined by the hydrostatic pressure in the capillaries minus the difference in osmotic pressure between the aqueous humour and the capillary plasma. If we put the lateral component of the hydrostatic pressure in the capillaries at about 50 mm. Hg, and the difference between the osmotic pressures of the two fluids at 30 mm. Hg, the resultant pressure in the chambers of the eye will be 20 mm. Hg.

2. The safety valve mechanism of the canal of Schlemm. It is pointed out by Duke-Elder that for the maintenance of a continuous circulation there must be a gradient of pressure within the eye. The arterial pressure within the eye must be higher than the capillary, the capillary higher than the venous, and the venous higher than the intraocular pressure. If the intraocular pressure were to rise above the venous pressure, the thin-walled veins would collapse. The average pressure in the intraocular arteries as given by Duke-Elder is 88 mm. of mercury systolic and 64 mm. of mercury diastolic for the retinal arteries and from about 50 to 55 mm. of mercury for the capillaries. The pressure in the vortex veins as given by Lullies¹² is from 9 to 20 mm. of mercury higher than the pressure in the anterior chamber. The pressure in the intrascleral veins, which includes Schlemm's canal, Duke-Elder found to be on the average 1.5 mm. of mercury higher than the intraocular pressure. (A list of pressure readings by various investigators is given by Thiel.²)

The safety valve mechanism of the canal of Schlemm is conceived as follows: Ordinarily the renewal and the removal of the fluid within the eye are determined by the "dynamic equilibrium existing on either side of the capillary walls between the balancing hydrostatic and osmotic pressures," as mentioned previously. In conditions of raised intraocular pressure, such as normally occurs due to the action of the pulse beat, the respiratory curve and the external muscles of the eye, the pressure in the anterior chamber is temporarily raised above that in Schlemm's canal. Fluid is then forced out of the anterior chamber into Schlemm's canal until the pressure is reduced to normal.

The theory of the safety valve mechanism of the canal of Schlemm is readily acceptable. It is also probable that the aqueous is eliminated through the canal of Schlemm when this is not acting as a safety valve

12. Lullies, H.: Der Druck in den Venen des Scleralkanals, Arch. f. d. ges. Physiol. 199:471. 1923.

and when the pressure in the anterior chamber is lower than that in the canal.

THE HYDROSTATIC-OSMOTIC EQUILIBRIUM THEORY

I return now to the first mechanism mentioned, the hydrostatic-osmotic equilibrium. This theory, of which Duke-Elder is the chief exponent, is based on a number of experimentally established facts and on a number of assumptions. The established facts are:

1. Proteins of the blood exert an osmotic pressure of about 30 mm. of mercury.

2. The hydrostatic pressure in the intraocular capillaries is from 25 to 30 mm. of mercury higher than the intraocular pressure.

3. It has been found by Donnan that when two solutions, one containing a colloid and crystalloids and the other crystalloids only, are separated by a semipermeable membrane through which the colloid is not diffusible, the crystalloids diffuse through the membrane until an equilibrium is established. The electrically charged colloid retains a number of ions of the opposite charge, so that there is on each side of the membrane an excess of diffusible ions of one charge over those of the opposite charge. When equilibrium is established, however, the product of the concentration of the cations and anions on one side of the membrane is equal to the product of the concentration of the cations and the anions on the other side of the membrane. This is the Donnan theorem.

4. It has been shown by Duke-Elder that the relation of the product of the concentration of cations and anions in the aqueous, which is free from protein, to that in the blood, which contains the nondiffusible protein, corresponds to the Donnan theorem.

5. There is a circulation of fluid within the eye. Fluid moves out of the blood stream into the posterior chamber and through the pupil into the anterior chamber and out again into the blood stream. The latest addition to the proof of such a circulation was made by Friedenwald and Pierce.¹³

6. It has been shown experimentally in animals that when the colloid content of the blood is increased intraocular pressure falls; when the colloid content of the blood is diminished intraocular pressure rises. Similarly, when the blood is made hypertonic with salt solution the intraocular pressure falls; when the blood is made hypotonic the intraocular pressure rises. When the intracapillary pressure in the eye is increased the intraocular pressure rises; when the intracapillary pressure in the eye falls the intraocular pressure also falls.

13. Friedenwald, J. S., and Pierce, H. F.: The Circulation of the Aqueous, *Arch. Ophth.* **7**:538 (April) 1932; **8**:9 (July) 1932; **10**:449 (Oct.) 1933; **14**:599 (Oct.) 1935.

The assumptions made on which this theory is based are:

1. "The capillary walls may be considered a semipermeable membrane . . ." (Duke-Elder¹⁴).

2. Fluid leaving and entering the capillaries moves through the capillary walls and tissues as it moves through an artificial semipermeable membrane.

3. From the experimentally established fact that the proteins of the blood have an osmotic power, it follows that the proteins in the blood exert an osmotic power on fluids on the other side of the capillary walls.

4. The change in the movement of fluid toward the blood stream or away from the blood stream when the colloid content of the blood or the salt content of the blood is either increased or diminished is simply the effect of either increased or diminished osmotic power of the constituents of the blood.

5. The Donnan membrane theorem necessarily plays a role in the body when two solutions with different ionic concentrations, and one of them containing protein, are separated from one another by a membrane.

The Capillary Wall as a Semipermeable Membrane.—Of great importance is the first assumption, that is, that the capillary wall may be considered a semipermeable membrane. It is assumed that the capillary wall behaves in the manner of an artificial semipermeable membrane which is used in the laboratory for the study of the diffusion of solutions. But there is actually no proof that this is so. There is no proof that the capillary wall when taken by itself away from all regulatory influences conforms to the criteria of an artificial semipermeable membrane as used in the laboratory. In fact, it is doubtful whether there is anywhere in the living body any separating membrane which corresponds to a strictly semipermeable membrane. There is a good deal of evidence that the contrary is the case; that the separating membranes in the body are not semipermeable membranes in the foregoing sense; that the movement of fluid through membranes and tissues in the body does not follow the laws of osmosis; that while there is some sort of balance between the fluids on the two sides of a membrane such as the capillary wall, such a balance need not and often does not correspond to the Donnan theorem.

The Movement of Fluid Through Living Membranes.—The fundamental work on the movement of solutions through living membranes has been done by Wertheimer¹⁵ in Abderhalden's laboratory in his

14. Duke-Elder,⁸ p. 443.

15. Wertheimer, E.: Ueber irreziproke Permeabilität, Arch. f. d. ges. Physiol. **199**:383, 1923; Ueber die Quellung geschichteter Membranen und ihre Beziehung zur Wasserwanderung, ibid. **208**:669, 1925; Weitere Untersuchungen an lebenden Membranen, ibid. **210**:527, 1925.

studies on the irreciprocal permeability of membranes. This work, which is easily accessible, has evidently not had the consideration it deserves. Similar work has been done on the eye by F. P. Fischer.¹⁶ Wertheimer found that in the living skin of the frog water diffuses more quickly from within outward than in the opposite direction. Under the conditions of the experiment, sodium chloride passed from without inward but not in the opposite direction. Such an irreciprocal permeability he found also with peptoné, polypeptide, amino acids and dextrose. The dead skin loses this irreciprocal permeability, and all substances diffuse equally.

Wertheimer also found that the ability of the living skin of the frog to bind water is different on the two sides. The external layer swells markedly in hundredth-normal sodium hydroxide solution, and the inner layer, only slightly; hundredth-normal sulfuric acid solution has the opposite effect. The cations potassium, rubidium, cesium, ammonium, lithium and sodium have different effects on the two surfaces. He noticed similar effects with nonelectrolytes.

Wertheimer found that the movement of water through the living membrane is dependent on the degree of swelling of the two sides when in contact with water. Water enters the living membrane only when the surface in contact with it can take it up. The greater its ability to take up water, the more of it enters the living membrane. Water does not pass through a living membrane as it does through a dead membrane or through an ultrafilter. Instead, the surface layer in contact with the water swells and then gives up its water to the contiguous layer until the water has passed through.

Similar observations were made by Wertheimer on the intestines of the pig.

Wertheimer also found that the two surface layers of living membranes have different ionic concentrations. In the skin of the frog the hydrogen ion concentration is greater in the outer surface layer, while the chloride ion concentration is greater in the inner surface layer. In the lung he found the hydrogen ion concentration greater in the layer near the inner surface, that is, the surface lined with respiratory epithelium, and the chloride ion concentration greater in the layer near the outer, or pleural, surface.

The results of the investigations of Wertheimer show that the rate of movement of water through a living membrane of many layers, such as the skin of the frog or the intestines of the rabbit and the pig, is influenced by the constellation of the electrolytes in the different surface

16. Fischer, F. P.: Untersuchungen über die Quellungsvorgänge und über Permeabilitätsverhältnisse der Hornhaut, *Arch. f. Augenh.* **98**:46, 1928; Ueber die Permeabilität der Hornhaut und über die Vitalfärbungen des vorderen Bulbusabschnittes mit Bemerkungen über die Vitalfärbungen des Plexus chorioideus, *ibid.* **100-101**:480, 1929.

layers of the membrane. There is nothing illogical in the assumption that the behavior of other living membranes in the body, such as the walls of the capillaries or the serous membranes, is similarly influenced by variations in ionic composition of their surface layers. The investigations show that the term semipermeable membrane as applied to an artificial or dead membrane cannot be applied to a living one, nor is there here simply a question of the size of the pores, as in a dead membrane. What Wertheimer found for the skin, the intestines and the lungs can without hesitation be applied to the capillary walls, which are multilayered membranes no matter how thin they are. For each capillary wall consists at least of a layer of endothelial cells, a basement membrane and Rouget cells, and each layer may be considered multilayered in a physical sense; in addition, the capillary wall is closely applied to the surrounding tissues, which again are multilayered. It is obvious, then, that a hydrostatic-osmotic balance cannot be the sole factor or even any factor in the movement of fluid through such membranes in the eye or anywhere in the body.

The Movement of Fluid Through the Cornea.—Studies similar to those of Wertheimer have been made by Fischer¹⁶ on the cornea. He studied the diffusion of fluids through the cornea and found there an irreciprocal permeability. Solutions which are able to pass through from without into the anterior chamber do not pass in the opposite direction. Again, substances which can pass from the anterior chamber outward through the cornea do not pass in the opposite direction. Fischer found that it is especially the endothelium of the cornea lining the anterior chamber and the epithelium covering the cornea which determine the passage of solutions. And it is the ability of the lining endothelium and epithelium to take up a solution and pass it on to the stroma which determines whether the solution can pass through the cornea. This characteristic of the endothelium and epithelium is evidently a stable and permanent one and can be changed artificially only by a change in the electrolytic content of the aqueous and tears. It is especially the endothelium in which this characteristic is easily recognizable. For it is this single layer of cells derived from mesoderm, as is the endothelial layer of the capillary wall, which prevents the aqueous from penetrating into the cornea. Damage to the endothelium is immediately followed by the entrance of aqueous into the stroma, an observation made long ago by Leber.

The Donnan Theorem in Relation to the Mineral Content of the Eye.—To determine whether the various structures in the eye are separated by semipermeable membranes and whether the Donnan theorem holds true for them, Fischer¹⁷ made an elaborate study of the

17. Fischer, F. P.: Der Mineralbestand des Auges, Arch. f. Augenh. **107**:295, 1933.

mineral contents of the cornea, lens and vitreous and compared them with the mineral contents of the aqueous and the blood serum. He made similar studies on the vascular tissues of the eye: the sclera, retina, iris, ciliary body and choroid. He used the eyes of pigs and cattle and studied the following cations and anions: sodium, potassium, calcium, magnesium, chlorine, phosphate and sulfate. Fischer¹⁸ came to the conclusion that while the distribution of the various ions between the aqueous and the blood serum may correspond closely to the requirements of the Donnan theorem, no such relation exists between the distribution of ions in the various refracting media. Here there is no Donnan distribution of ions whether in relation to the blood or to the aqueous. For each ion there is a different distribution factor. In his discussion Fischer quoted from a lecture by Donnan delivered in Mainz in 1932, in which he pointed out that in the living tissues, so far as they are "living," thermodynamic equilibria cannot exist because free energy is continuously brought to the tissues in the form of substances which assimilate oxygen. These substances are continually changed into lower as well as higher potentials, while with a thermodynamic equilibrium the free energy reaches a molecular-static minimum. In other words, a system existing in a thermodynamic equilibrium is surely completely "dead."¹⁹ "Disequilibria, not equilibria arise and are maintained as long as life remains."

Fischer stressed the constancy of the mineral composition of the tissues of the eye, which must unequivocally be described as different from their surroundings. In his summary he gave the following conclusion:²⁰

It is concluded from the differences in the mineral content of the tissues and their surroundings, the tissues as well as the fluids of the eye, that conditions of thermodynamic equilibria, ionic distribution according to the Donnan theorem, do not exist and cannot exist as long as the tissues have not died.

In a recent publication Robertson²¹ reviewed critically the results of Duke-Elder in regard to the chemical and the physical equilibrium between the blood and the aqueous. His own investigations led him to conclude:

. . . there is evidence to show that there is no chemical equilibrium between the blood and the aqueous humour. Easily diffusible constituents such as urea, sugar, uric acid, are not present in equal concentrations in blood compared with the corresponding aqueous. . . . There is evidence that a physical equilibrium does not exist between blood and aqueous and that the equilibrium level of the intraocular pressure is not maintained by the hydrostatic force in the capillaries minus the difference in osmotic pressure between the aqueous and the blood.

18. Fischer,¹⁷ p. 305.

19. Fischer,¹⁷ p. 306.

20. Fischer,¹⁷ p. 318.

21. Robertson, J. D.: An Investigation into the Theories and the Formation and Exit of Intraocular Fluids, *Brit. J. Ophth.* **21**:401, 1937.

With the work of Wertheimer and of Fischer in mind, it is not possible to accept the hydrostatic-osmotic theory for the maintenance of intraocular pressure. Unquestionably intravascular pressure in the eye is of importance, but the balance between hydrostatic and osmotic pressure does not have anything to do with the maintenance of normal intraocular pressure. How then is one to explain the experimental results previously discussed, namely, the movement of fluid into the blood stream and the fall of intraocular pressure following the intravenous injection of colloid substances and hypertonic salt solution? And how is one to explain the opposite effect when the blood is made hypotonic?

MAINTENANCE OF PHYSIOLOGIC VALUES AT A CONSTANT LEVEL

This brings one to the crux of the whole problem, which is that attempts to explain physiologic functions cannot be based on a few purely physical forces without taking into consideration the strictly physiologic element, which is regulatory. Fischer in his summary recognized this difficulty and he stated in the last sentence: "A consideration of the facts found must lead to the conclusion that the mineral contents of the tissues must be held constant within physiological limits by a regulatory mechanism of a special kind." This is physiology, the physiology of constant values. The blood, which is part of the internal milieu in the sense of Claude Bernard, is the phylogenetically evolved optimum for the organism, and its composition is maintained at a constant level within physiologic limits at a considerable effort on the part of the organism. When nonphysiologic solutions of sodium chloride, whether hypertonic or hypotonic, or when nonphysiologic colloids are injected into the blood stream or when the amount of protein in the blood is artificially changed, there is an attempt on the part of the organism to reject the nonphysiologic part and reconstruct the normal composition of the blood. Numerous complex mechanisms are set in motion which eventually cause a return to normal. As a result of these complex processes, fluid moves toward the blood stream to dilute the hypertonic salt solution or the colloid or away from the blood to reestablish the normal concentration when the blood is hypotonic. The movement is in response to reflex regulatory demands, and the movement through the capillary walls does not imply the action of osmotic forces but much more complex ones in the sense in which Wertheimer found them in his studies on multilayered membranes, and these forces are regulated by the phylogenetically evolved adaptive constellation of electrolytes and a central nervous control through neural and hormonal influences. It is, of course, natural that with large amounts of fluid moving outward from the blood stream into the tissues in response to

regulatory activities the eye will get a little of it, or that with fluid moving toward the blood stream the eye will lose a little of its water content.

The experiments which cause a change in the intraocular pressure by changing the composition of the blood can therefore not be used as evidence for the theory of hydrostatic-osmotic balance. It is necessary to come to the conclusion that no theory which has as its foundation the balancing of several physical forces alone can explain the maintenance of normal intraocular pressure.

This brings me to the point just barely touched on by Fischer, that of a regulatory mechanism, and to the wider view of physiologic regulation as pointed out by Claude Bernard in his discussion of the internal milieu, by Haldane²² in his "New Physiology" and more recently by Barcroft²³ in his "Features in the Architecture of Physiological Function."

The Mechanism for the Maintenance of a Constant Physiologic Value.—The living organism continuously attempts to maintain normal values within narrow limits of variation for those substances which it needs in its economy and for those processes and activities within itself to which it has become adapted. Claude Bernard mentioned water, oxygen, temperature and chemical substances. It is obvious that all processes in the body must be included—the maintenance of normal temperature, blood pressure, blood volume, individual constituents of the blood, general metabolism, metabolism of the individual foodstuffs, digestion and respiration; in short, everything that happens in the body, including, of course, the maintenance of the normal intraocular pressure. While the means of maintenance of the normal value of some of these processes is relatively well understood, little is known of others. It is known, however, that the means which the organism uses to maintain normal physiologic values are in general similar in all processes. These consist of, first, effector organs; second, a central regulating mechanism in the central nervous system, and, third, channels through which the central apparatus influences the effector organs.

1. Effector Organs: The effector organs perform the function for which they are provided. In them function is regulated by means of electrolytes, mainly, the cations hydrogen, sodium, potassium, calcium and magnesium and the anions hydroxide, chlorine and phosphate and probably others. A change in constellation of these electrolytes changes the rate of functioning of the effector organs. An easy example is the

22. Haldane, J. S.: *The New Physiology*, in Harvey Lectures, 1916-1917, Philadelphia, J. B. Lippincott Company, 1918, p. 21.

23. Barcroft, J.: *Features in the Architecture of Physiological Function*, London, Cambridge University Press, 1934.

heart beat, which is changed by altering the sodium, potassium and calcium contents of the nutritive fluid.

2. Central Regulation: The regulating mechanism is found in the central nervous system, in which the phylogenetically old vegetative functions have their seat of control in the gray matter surrounding the central canal in the spinal cord and around the third and fourth ventricles in the brain stem. The highest developed centers for these functions are found in the gray matter surrounding the third ventricle, in the hypothalamus. The increasing amount of investigation in this region of the brain has shown that it contains the centers of control of temperature, sleep, water movement, metabolism, blood pressure and even the emotions. Lower down, in the region of the aqueduct, the fourth ventricle and the spinal cord are the controls for the more primitive vegetative functions. While knowledge concerning the centers of regulation for vegetative functions is thus increasing, there are innumerable bodily functions the centers of regulation of which have not been located. That in the economy of the organism they are centrally regulated must necessarily be assumed.

3. Channels of Influence: There are two channels through which the hypothalamic centers can influence bodily function. The first is by means of neural connections with the nuclei of the sympathetic and parasympathetic nervous systems. There are known connections between the hypothalamus and the somatic and visceral centers of the brain stem and spinal cord and through the spinal cord with the sympathetic system.²⁴ The sympathetic and parasympathetic fibers end in the cells and tissues of the effector organs.

The second channel of influence is through the hormones. It has been shown that nerve fibers running from the hypothalamus to the pars nervosa of the hypophysis influence the secretion of this gland, which, entering the circulation, reaches many effector organs.

MAINTENANCE OF THE NORMAL INTRAOCULAR PRESSURE

The normal intraocular pressure is an evolved optimum for the eye and is maintained within narrow limits of variation. In the light of the previous discussion, I conceive the normal intraocular pressure to be maintained by a unit mechanism consisting of an effector organ, a center of control and neural and hormonal channels by which the center exerts its influence on the effector organ. The whole mechanism acts as a unit to maintain the intraocular pressure at a certain level. With any slight change in pressure, afferent impulses are carried to the center, which reacts by influencing the effector organ to reestablish the normal pressure.

24. Ranson, S. W.: Some Functions of the Hypothalamus, in Harvey Lectures, 1936-1937, Baltimore, Williams & Wilkins Company, 1937, p. 92.

The Effector Organ.—In discussing the individual structures of the eye in relation to intraocular pressure, it was concluded that except for the passive action of the slightly distensible sclera, it is the blood and the circulating fluid in the eye, the aqueous, which maintain the pressure within the eye. There are then two elements which constitute the means of maintaining the normal pressure within the eye: (1) the quantity of circulating fluid, which must be of a constant value within narrow limits of variation, and (2) the quantity of the circulating blood within the eye, which must be of a constant value within similar limits.

1. The aqueous is a watery solution of certain electrolytes and non-electrolytes which enters the chambers of the eye by passing through the capillary walls and, after circulating in the eye, passes into the venous system, especially by way of Schlemm's canal. The capillary walls in the eye and the wall of Schlemm's canal, no matter how thin, must be considered, like all separating membranes in the body, as multi-layered membranes. The passage of fluid through them into the chambers of the eye and out I conceive to occur in a manner similar to that which Wertheimer found in his studies on the passage of solutions through multilayered living membranes. According to this, the entrance and exit of fluid are regulated to maintain the pressure of the eye, first, by the constellation of the electrolytes in the layers of the walls of the capillaries and adjacent tissues; second, by the ability of each layer to take up fluid, and, third, by the extent and size of the capillary bed.

2. The second factor, the quantity of the circulating blood, determines the size of the capillary bed. The vessels which come under consideration are those of the uveal tract, for the retinal circulation is quasi-independent. The quantity of blood in the uvea is dependent on the degree of contraction of the capillaries and on the number of capillaries open at one time. Regulation of the size of the bed is necessary, for it is clear that when it is increased the extent of the capillary wall through which fluid passes is increased, and when it is diminished, the size of the capillary wall is diminished. The means of regulation is conceived to be within the capillary wall itself, with the additional regulation of nerves and hormones. Evidence for this can be found in the work of investigators in this field. In addition to these means of regulation in the wall itself, the blood volume in the capillaries is also kept at normal by the contraction of the arteries and, more important, by the regulation of the outflow from the veins. Diminution in the outflow of blood from the veins is quickly followed by dilatation of the capillaries and, if pathologic, by stasis.

The blood of the uveal tract is finally collected in the vortex veins. Before entering the sclera, each vortex vein dilates to form an ampulla

and then narrows as it enters the emissary canal. In its course through the first part of the emissary canal the wall of the vortex vein is very thin (from 0.004 to 0.006 mm.), but shortly before its exit from the canal it suddenly becomes thicker (from 0.02 to 0.06 mm.). This is due to an increase of connective tissue of the adventitia and also to the addition of circular and longitudinal muscle fibers.²⁵ The presence of muscle fibers means that the vessel can be narrowed by their contraction, and it is possible that there is, here, an additional mechanism for the regulation of the outflow of blood, a mechanism the importance of which has, perhaps, not been sufficiently appreciated.

In the normal eye the amount of blood remains within definite limits, and only a definite amount enters the arterial system, just enough to keep the capillary bed within the necessary size and extent. It is balanced by the amount of blood leaving the veins, the whole forming a unit considerably independent of the general circulation.

The effector organ for the maintenance of the normal intraocular pressure thus consists of, in addition to the sclerocorneal coat, at least three units: (1) the capillary walls and the walls of Schlemm's canal, the passage of fluid through which is regulated by the electrolytic content of its layers; (2) the amount of circulating aqueous, and (3) the amount of circulating blood. In order to work smoothly and continuously under all conditions such a complex organ must have central regulation. It is hardly conceivable that it can be otherwise. What evidence is there that nerves and hormones control it?

Neural Control.—It has been known for a long time that the vessels in the eye are controlled by fibers from the sympathetic nervous system. The evidence for it is reviewed by Thiel and by Duke-Elder. Histologically, a great network of fibers is found everywhere in the uveal tract, especially around the capillaries. Experimentally, it is hardly possible to separate any effect of the sympathetic fibers on the capillaries from the effect on the large vessels. Stimulation of the cervical sympathetic fibers produces an effect on many structures—small and large arteries, capillaries and the smooth muscle fibers of the orbit. Therefore, the effect of the activity of the sympathetic nerve fiber, in controlling the effector organ for the maintenance of intraocular pressure cannot be gaged from such experiments. But the very presence of fibers points to control by the sympathetic nervous system.

Parasympathetic fibers have not been traced to the capillary walls or to the walls of the larger blood vessels. Experimentally, axon reflexes which cause vasodilatation through antidromic activity followed by an increase in intraocular pressure have been shown to occur. These axon reflexes are mediated through the sensory fibers of the trigeminal nerve.

25. Lauber, H., in von Möllendorff, W.: *Handbuch der mikroskopischen Anatomie*, Berlin, Julius Springer, 1936, vol. 3, pt. 2, p. 83.

The only real evidence for activity of the parasympathetic fibers is in the work of Velhagen,²⁶ who found that in the uvea and retina choline and acetylcholine occur, the latter being probably identical with the "parasympathetic stuff" of Loewi.

Hormonal Control.—There is little actual proof that the intraocular pressure is under hormonal influence. The contradictory evidence is reviewed by Thiel,² who, however, came to the conclusion that "undoubtedly there is an influence of the endocrine system on the intraocular pressure." In spite of the insufficient evidence, I am convinced that in analogy with other vegetative functions hormonal control constitutes one of the means of control of the normal intraocular pressure.

Central Regulation.—Nothing is known of any center in the brain which controls the maintenance of intraocular pressure. In spite of this, it is necessary to hold to the conviction that there is such a controlling center and to expect that it will eventually be found by future investigators. Such a center would probably be located in the brain stem, in the gray matter surrounding the canal system, where it would be in connection with the sympathetic system, possibly in the hypothalamus, where so many of the centers for vegetative functions are located. The considerations which lead me to assume the existence of such a center, I have already discussed. Mainly, they are: (1) the analogy with other vegetative functions which are known to be controlled by a center in the brain; (2) the inadequacy of the assumption that the action of purely physical forces alone and without regulation can explain the maintenance of such a physiologic constant as the normal intraocular pressure, and (3) the independence of the maintenance of the normal intraocular pressure from other bodily functions. This may also be considered, that the intraocular pressure reacts to some degree with the activities of the body known to be influenced by hypothalamic centers. Especially is this the case with the emotions, which are known to have an effect on the intraocular pressure. It is now known that the center for the integration of visceral and somatic components of emotional expression is in the hypothalamus.²⁴

Normal Variations in Intraocular Pressure.—The conception that the intraocular pressure is maintained by a unit mechanism consisting of an effector organ, a center of control and channels through which control is exercised permits at once an understanding of the normal variations in intraocular pressure. The diurnal variations are in close analogy with the diurnal variations in other vegetative functions which are maintained by such mechanisms. It is known that such variations

26. Velhagen, K., Jr.: Zur Frage der vagotropen Substanzen im Auge, Arch. f. Augenh. **105**:573, 1932.

occur in blood pressure, temperature, sugar content of the blood, metabolism and other bodily functions. This conception also permits an understanding of the mechanism of compensation when there is any untoward disturbance in the effector organ. The external ocular muscles exert pressure on the eye and raise the intraocular pressure. An undue rise in pressure causes afferent impulses to be carried to the center, which responds by influencing the effector organ through the nerves and hormones to reestablish the normal pressure. The time which it takes for this compensation to be effected can be studied by exerting a measured amount of pressure on the eye and studying the time it takes for the pressure to return to normal. Such studies have been made (Duke-Elder ²⁷).

CHRONIC SIMPLE, OR PRIMARY, GLAUCOMA

With the conception of the maintenance of the normal intraocular pressure as outlined, I shall now attempt to explain the pathogenesis of chronic simple glaucoma.

Chronic simple, or primary, glaucoma is a condition in which the intraocular pressure is persistently higher than the optimum for the normal eye and is above that which the eye can withstand for a long time without damage. The condition comes on gradually and insidiously at or after the age of 40 and usually involves both eyes; when it is not checked it eventually leads to blindness. It differs from secondary glaucoma in that it is not secondary to any other illness in the eye and in that there is no apparent cause for its appearance. In this as well as in the age at which it makes its appearance it resembles other diseases which are due to a change in regulation, especially essential arterial hypertension and diabetes.

SYMPTOMS

In the consideration of the symptoms of chronic simple glaucoma it is necessary to separate sharply the ocular changes which are the result of the persistently high tension from the symptoms which appear early in the course of the disease. The main change which is due to the persistently high pressure within the eye is in the posterior segment, the excavation of the disk, with the gradual destruction of one bundle of nerve fibers after another. In the anterior segment the changes are the pushing forward of the lens-iris diaphragm, with the consequent diminution in the depth of the anterior chamber; in the iridocorneal angle the changes are atrophy of the trabeculae, the increased amount of pigment deposit and the narrowing and complete obliteration of the angle and the atrophy of the iris and the synechia between the root of the iris and the cornea. With the destruction of the

27. Duke-Elder,⁸ p. 501.

nerve fiber bundles, there is the corresponding loss of the visual field. All these changes, which are the result of a long continued increase in the intraocular pressure, do not give any clue to the pathogenesis of the disease.

Early Changes.—The picture is entirely different in the early stages of the disease. Here there are practically no visible alterations in the eye either in the anterior segment or in the optic disk, and the eye does not differ in appearance from a normal eye. There are no changes in the acuity of vision or in the visual field. There are no subjective complaints in the early stages, with the exception perhaps of headache occurring occasionally in the morning or after a prolonged stay in a dark room. The increase in intraocular pressure is usually found on routine examination when deliberate test is made for it. Subjective symptoms begin to appear with the secondary changes previously mentioned. When the intraocular tension is tested by means of a tonometer, the characteristic changes of the early stages are found, and these are:

1. An increased tension which varies considerably but is most frequently between 30 and 50 mm. of mercury, occasionally higher and sometimes lower. In some cases the tension is within the normal limits most of the day, rising only in the early morning hours.

2. Diurnal variations in tension. In the normal eye these variations are small, from 2 to 3 mm.; in the glaucomatous eye they vary as much as 20 mm., and the daily curve frequently has two peaks, one in the middle of the night and one in the morning.

3. The behavior of the intraocular tension in response to certain tests. These tests are:

- (a) The administration of caffeine. The tension in the normal eye is not increased, while in the glaucomatous eye there is a decided increase of 10 mm. or more.

- (b) Compression of the veins of the neck by means of a tourniquet or by lowering the head. This gives a similar increase in the glaucomatous eye, but not in the normal eye.

- (c) The dark room test. The patient is put in a dark room for an hour. The tension in the glaucomatous eye rises with a variation of from 10 to 40 mm. and returns to the previous reading when the patient gazes at a brightly illuminated wall. The normal eye shows no variations.

- (d) Massage of the eye. The tonometer with the 10 or 15 Gm. weight is placed on the eye and kept there for a number of minutes. In the normal eye this is followed by a marked drop in tension; in the glaucomatous eye the tension does not go down at all or drops much less than in the normal eye, then quickly returns to its previous reading and frequently exceeds it.

(e) Puncture of the anterior chamber. Kronfeld²⁸ found that when the anterior chamber in the normal eye is punctured with a needle and the aqueous withdrawn the intraocular tension returns to normal in about two hours. In cases of simple glaucoma with normal tension the tension rises to 50 and 60 mm. of mercury after one or one and a half hours.

Age.—In addition to the changed behavior of the intraocular pressure, the age at which chronic simple glaucoma makes its appearance is of importance. Since there are no subjective symptoms in the early stages of glaucoma, statistical reports are not always reliable in giving the actual ages at which chronic simple glaucoma begins to appear. In a recent statistical study, Lehrfeld and Reber,²⁹ from the Wills Hospital in Philadelphia, found 20 patients with juvenile glaucoma (that is, they were below the age of 35 years) and 1,023 patients with simple glaucoma (40 years of age and over) in a group of 1,876 patients with all varieties of glaucoma.

Characteristics of the Early Stage.—When these changes in the intraocular pressure are reviewed, it is clear that the eye with chronic simple glaucoma in the early stages differs from the normal eye in three characteristics: first, the greater lability or instability of the intraocular pressure during the twenty-four hours of the day, even when the low readings are still within the normal limits; second, the gradual increase in the intraocular pressure above that for the normal eye, and, third, the appearance of these changes, except in the rare cases of juvenile glaucoma, at middle age, that is, at about the age of 40 years or later. The course is somewhat as follows: At about the age of 40 years or shortly before that, the intraocular pressure becomes more labile during the twenty-four hours and shows greater variations. Tests made at this time show greater variations in response than in a normal eye. This lability or instability persists, and within an indefinite period of time, perhaps a few years, the tension not only shows the greater variations but continues to be higher than that of a normal eye. Again in an indefinite period of time the pressure becomes still higher, and with this persisting, secondary changes begin to appear. During the period when the tension is higher there is an additional increment of fluid within the globe, but the amount of fluid entering the eye and leaving it is perfectly balanced. For were it not balanced, a quick and sudden increase of pressure with all its attendant acute changes in the eye would be the result, and maintenance of pressure even at the higher level of from 30 to 50 mm. continuously would be impossible.

28. Kronfeld, P. C.: Das Verhalten des intraokularen Druckes nach Vorderkammerpunktion bei Glaukom, Ztschr. f. Augenh. 7:48, 1930; Modern Viewpoints as to the Mechanism of Glaucoma, Am. J. Ophth. 12:480, 1929.

29. Lehrfeld, L., and Reber, J.: Glaucoma at the Wills Hospital, 1926-1935, Arch. Ophth. 18:712 (Nov.) 1937.

COMPARISON OF CHRONIC SIMPLE GLAUCOMA WITH
OTHER DISEASES

The changes in the intraocular pressure as they occur in the early stages of chronic simple glaucoma can be compared with the early changes in other diseases which are the result of a change in regulation.

Observation of the course of essential arterial hypertension will show that around middle age there is a greater lability of the normal blood pressure, with an increase above normal during certain periods and the return to normal during others. Within an indefinite period of time the blood pressure gradually rises and persists at a higher level while keeping its greater lability. Within a further period of time the blood pressure rises still higher, and with its persistence at the high level secondary changes in the arterial system occur. Again, as in cases of chronic simple glaucoma, juvenile arterial hypertension occasionally occurs.

A comparison of diabetes with chronic simple glaucoma will disclose a similar course. Around middle age there is a variation in the sugar content of the blood; it is higher in some periods and returns to normal at others. Within an indefinite period of time the blood sugar is maintained at a higher level, still keeping its abnormal variations. Within a further period of time it is found to be at a still higher level, and when this condition is unchecked and untreated, secondary nutritional changes soon result.

The comparison of chronic simple glaucoma in its early course with the early course of such diseases as essential arterial hypertension and diabetes makes one aware of the fact that chronic simple glaucoma belongs to a group of diseases which are characterized primarily by a change in regulation. There are unquestionably other diseases belonging to this group. In all these diseases there occurs in advancing life a change in the maintenance of certain physiologic values. In essential hypertension it is the maintenance of the normal blood pressure; in diabetes it is the maintenance of the normal sugar content in the blood, and in chronic simple glaucoma it is the maintenance of the normal intraocular pressure. The regulatory mechanism for the maintenance of each of these values first becomes unstable and variable and is gradually so geared or so constituted as to maintain the value at a higher level. The maintenance of such a physiologic value at a higher level, not being the evolved optimum for the organism, eventually causes damage to the organism.

PATHOGENESIS OF CHRONIC SIMPLE GLAUCOMA

In the discussion on the maintenance of the normal intraocular pressure, I came to the conclusion that it is maintained by a unit mechanism which consists of an effector organ in the eye, channels for

neural and hormonal control and a still unknown center in the brain stem. Applying this conception of the maintenance of the normal intraocular pressure to the changes in intraocular pressure in chronic simple glaucoma, I come to the following conclusion: The effector organ in the eye has evidently not lost its ability of allowing the proper amount of fluid to pass into the eye and the corresponding amount of fluid out of the eye. The only change is that there is an increment of fluid in the eye, which is at first temporary and later permanent. The central control and the channels through which control is exercised still function, as seen by the maintenance of a pressure level, although the level is now higher. Instead of maintaining the evolved optimum of intraocular pressure, the unit mechanism has gradually changed its gearing and is now working with the same effector organ and the same channels of control to maintain the intraocular pressure at a higher level. It is not in a particular structure of the eye that one need look for the cause of this alteration in function and not in the effector organ or in the channels of control. The change is either in the center of control itself or in the unit mechanism as a whole. The phylogenetically evolved mechanism for the maintenance of the optimum intraocular pressure is in some persons not the stable mechanism that it should be. At an early period it shows its lack of stability by greater daily variations and by the abnormal responses to tests and finally it loses more and more its ability to maintain the normal pressure.

ETIOLOGIC FACTORS

When one looks for any cause for the loss of stability of the mechanism for the maintenance of the normal intraocular pressure, none is apparent. A review of statistical reports shows that there is no great difference in the incidence of chronic simple glaucoma in the two sexes; that race does not play a role, and that no general or systemic disease of any kind can be held responsible in its causation. There are only two factors which have any meaning in these reports, the age factor, which I have already discussed, and the factor of heredity.

Heredity as a factor in the production of chronic simple glaucoma has long been known, and the occurrence of glaucoma in several members of a family is not uncommon. The type of heredity is that of a dominant one. Plocher³⁰ reported the occurrence of glaucoma in 17 persons in a family of 46 members in five generations. Von Graefe pointed out the phenomenon of "anticipation," that is, the appearance of glaucoma at an earlier age in the members of the subsequent generations. Loehlein, Lawford, Nettleship and many others have reported cases of hereditary glaucoma, and the literature has been reviewed by

30. Plocher, R.: Beitrag zum juvenilem familiären Glaukom, *Klin. Monatsbl. f. Augenh.* 60:592, 1918.

Franceschetti³¹ and by Waardenburg,³² who was able to follow cases of simple glaucoma in two or three generations.

There remains nothing else at the present state of knowledge but to conclude that the loss of stability in the mechanism for the maintenance of the normal intraocular pressure in some persons is the result of an inherited defect already present in the germ plasm.

CONCLUSION

I conceive the pathogenesis of chronic simple glaucoma to be as follows: In certain persons there is as a result of inherited influences a mechanism for the maintenance of the normal intraocular pressure which is constitutionally inferior. This constitutional inferiority is already inherent in the germ plasm and is the cause of the comparatively shorter period of normal activity of the whole mechanism or of its central regulation. In advancing life in most cases, or in early life in the rare cases of juvenile glaucoma, this mechanism as a whole loses its normal stability and is at first able to maintain the normal intraocular pressure only in an incomplete manner. This is shown by the diurnal variations in the intraocular pressure and by the abnormal variations to tests. Within a further indefinite period of time the ability to maintain the normal intraocular pressure becomes still more limited, and the mechanism is now so geared or so constituted as to maintain the intraocular pressure only at a higher level, usually from about 30 to 50 mm. of mercury. The change is either in the mechanism as a whole or in its central regulation. The change in function cannot be considered as being due to an alteration in some individual structure in the eye, whether the sclera, iridocorneal angle, vitreous, uveal blood vessels or nerve supply. With the persistently higher intraocular pressure, which is not the evolved optimum for the organism, secondary changes appear in the various structures of the eye and are found in the later stages of the disease. Chronic simple glaucoma is a disease in which there has occurred a change in the regulation of the maintenance of a normal physiologic value, namely, the normal intraocular pressure.

The pathogenesis of chronic simple glaucoma is comparable to the pathogenesis of certain other diseases in which there occurs in advancing life a change in the regulation of certain physiologic values. Of such diseases, essential arterial hypertension and diabetes are the best examples.

31. Franceschetti, A.: *Die Vererbung von Augenleiden*, in Schieck, F., and Brückner, A.: *Kurzes Handbuch der Ophthalmologie*, Berlin, Julius Springer, 1930, vol. 1, p. 773.

32. Waardenburg, P. J.: *Das menschliche Auge und seine Erbanlagen*, Haag, Nijhoff, 1932, vol. 7, p. 327.

News and Notes

EDITED BY W. L. BENEDICT

SOCIETY NEWS

British Medical Association, Section on Ophthalmology.—The Section on Ophthalmology of the British Medical Association, which meets in Plymouth, will hold meetings on July 21 and 22. The program for the two days is as follows:

On Thursday, July 21, at 10 a. m., "Co-Operation Between the Ophthalmologist and the Physician in Certain Cases of Visual Loss" will be discussed. The discussion will be opened by Mr. C. B. F. Tivy, Plymouth, followed by Dr. R. N. Craig, Exeter; Prof. J. A. Nixon, Bristol; Dr. C. M. Hinds Howell, London, and Dr. Edward McCulloch, Plymouth.

On Friday, July 22, at 10 a. m., the following papers will be read, followed by a discussion: "Some Special Problems in the Pathology of Glaucoma," Dr. Karl Wessely, Munich; "The Contact Lens Centre—Its Purpose and Policy," Mr. A. Rugg-Gunn, London; "Corneal Transplantation," Mr. J. W. Tudor Thomas, Cardiff; "Vital Staining of the Fundus," Mr. Arnold Sorsby, London; "The Avian Nictitating Membrane," Mr. A. L. Candler and Mr. Norman L. Capener, Exeter. At 2:30 p. m., Miss Ida Mann, London, will give a demonstration of patients fitted with contact lenses.

The president of the section is Sir Stewart Duke-Elder, and the honorary secretaries are, R. W. Payne, 1, The Crescent, Plymouth, and Wing Commander P. C. Livingston, Central Medical Establishment, Royal Air Force, 3-4 Clements Inn, W. C. 2.

Chengtu Eye, Ear, Nose and Throat Society.—The Chengtu Eye, Ear, Nose and Throat Society, the first society in China representing jointly practitioners in ophthalmology and in otolaryngology, was organized at the Eye, Ear, Nose and Throat Hospital at Chengtu, West China, on Dec. 14, 1937. The following officers were elected: Dr. Eugene Chan, president; Dr. Robert A. Peterson, vice president; Dr. C. C. Teng, secretary; Dr. C. R. Peng, treasurer, and Drs. M. L. Hu, K. C. Lang, T. C. Shih and C. C. Teng, editorial committee. The society will meet at the Chengtu Eye, Ear, Nose and Throat Hospital on the second Tuesday of each month at 6 p. m.

The members of this society are derived from the departments of ophthalmology and otolaryngology of the West China Union University at Chengtu, of the National Medical College at Nanking and of Cheeloo University at Tsinan, Shantung, and from practitioners in Chengtu and other centers of West China who are specializing in these fields. The transfer of faculties and students of medical schools from the war zone in East China to Chengtu has created there a unique center of teaching and clinical activity. The transfer has afforded the opportunity of combining the staffs of the departments

of ophthalmology and otolaryngology from these schools with these departments of the College of Medicine of the West China Union University in the continued development of its undergraduate and graduate teaching and clinical program.

Eye Section, Philadelphia County Medical Society.—The scientific meeting of the Eye Section of the Philadelphia County Medical Society was held on May 5, 1938, at the Philadelphia County Medical Society Building. The program consisted of the following presentations: "Drusen of the Optic Nerve," with the exhibition of a case, by Dr. George W. Mackenzie; "Growth in the Vitreous," with the exhibition of a case, by Dr. Mortimer W. Blair, and "Present Status of and Technic for Keratoplasty," by Dr. Ramon Castroviejo, New York.

GENERAL NEWS

Graduate Course in Ophthalmology, University of Rochester.—On Aug. 8-11, 1938, the department of ophthalmology of the University of Rochester School of Medicine and Dentistry will offer at the ninth annual summer graduate course in ophthalmology a comprehensive symposium on refraction and related subjects. While the main part of the course will be devoted to this single important phase of the practice of ophthalmology, sufficient time will be allowed for thorough discussions with the visiting lecturers, who are eminent in the field of medical refraction.

Among the subjects to be presented are: "The History of Spectacles;" "Optical Glass;" "A Practical Review of Physiologic Optics;" "Theories of Accommodation;" "Test Lenses, Correcting Lenses and Optometers;" "Refraction, a Medical Problem;" "Retinoscopy, Types and Methods;" "Subjective Methods of Refraction;" "Astigmatic Dials and Charts;" "Use of the Keratometer;" "Choice of Cycloplegia;" "Benzedrine in Refraction;" "Accommodative States;" "Presbyopia, Hyperopia and Myopia;" "Determination of the Astigmatic Axis with the Cross Cylinders and Astigmatic Dial;" "Choice of Bifocal Lenses;" "Muscle Imbalance;" "Orthoptics in Phorias and Tropias;" "Correction of Aphakia;" "Aniseikonia;" "Telescopic Spectacles;" "Contact Lenses;" "Pitfalls of Refraction;" "Spectacle Fitting," and "Checking the Prescribed Lenses."

A list of the guest lecturers follows: Dr. Walter B. Lancaster, Dr. Avery de Hart Prangen, Dr. S. Judd Beach, Dr. Wendell L. Hughes, Dr. George P. Guibor, Theodore E. Obrig, John G. Paul, Scott Sterling, Frederick W. Jobe and Irving Lueck.

Abstracts from Current Literature

EDITED BY DR. WILLIAM ZENTMAYER

General

HEREDITARY CHARACTER OF SOME OCULAR DISEASES. E. BIRO, Arch. d'opht. 53: 685 (Sept.) 1936.

In discussing senile cataract, Biro points out that few ophthalmologists have the opportunity to observe the hereditary nature of senile cataract through several generations. He presents the genealogic trees of two families. The evidence at hand indicates that the hereditary nature of senile cataract is dominant. That of congenital ectopia is also probably dominant. An observation of its occurrence in two generations is cited. Genealogic trees of two families in which cases of pigmentary degeneration of the retina occurred are presented. Reference is made to the relation of the dominant or recessive character to the severity of the condition. The consensus is that when it is recessive complications are more often present; when it is dominant, the retinal changes alone are present. The influence of consanguinity is also discussed. A genealogic tree of a family in which some of the members had congenital ptosis and in which the heredity was dominant is presented. Biro discusses the question of whether the condition is due to a defective muscle supply or to a defective nerve supply, as in some cases it has been shown to be due to one factor and in some to the other. In the cases in which operation was performed by the author, histologic study showed a marked thinning of the levator muscle. S. B. MARLOW.

General Diseases

HEMOLYTIC STREPTOCOCCUS SEPTICOPYEMIA OF OBSCURE ORIGIN, WITH FAILURE OF SULFANILAMIDE IN TREATMENT. M. VAISBERG, M. Rec. 146:516 (Dec. 15) 1937.

A white man aged 41, a chronic alcoholic addict who had received intensive malarial therapy for syphilis, sustained a marked proptosis (out and down) of the right eye and numerous contusions and abrasions about the head and jaws as a result of a severe beating.

The right eye was immobile. The conjunctiva was prolapsed above and below and filled with gas bubbles. Vision was limited to perception of light. Tension was 36 mm. of mercury (Schiotz). Prophylactic gas gangrene and tetanus serum was given, and in eleven days practically all the ocular symptoms cleared. During this time the left side of the lower jaw was slightly painful and swollen, but an injection of milk apparently helped. Dental care was instituted for the badly diseased teeth.

On the sixteenth day signs of an acute severe general infection developed, with complete loss of vision in the left eye within twenty-four hours. The pupil was dilated at maximum, and the cornea was clouded.

There was excruciating pain, with a tension of 35 mm. of mercury (Schiotz). A large bleb was present on the right heel. There was a foul discharge from the fistula in the left side of the lower jaw. Since the complete picture had not yet developed, an operation for glaucoma was performed to relieve the excessive tension of the left eye; the bleb on the right heel was incised, and a tooth was removed at the site of the infection in the jaw. Sulfanilamide was administered in doses of 90 grains (5.85 Gm.) daily and continued until the patient died.

Despite therapy, infected embolic infarcts developed in the toes and fingers and became progressively worse. Culture from the bleb showed a hemolytic streptococcus. Twenty thousand units of antistreptococcus serum was given daily in addition to the sulfanilamide, but without any benefit. Eight days after the onset of the septicopyemia, the patient died. Autopsy showed a normal brain, an embolus of the central artery of the left retina, osteomyelitis of the left side of the lower jaw, pyopericardium, and infected infarcts in the spleen and kidneys. The organism cultured from the pus in the pericardium was a hemolytic streptococcus.

AUTHOR'S ABSTRACT.

OCULAR MANIFESTATIONS OF BACILLARY DYSENTERY. TOULANT and SARROUY, Arch. d'opht. 53: 523 (July) 1936.

Bacterologic uncertainty makes it difficult to individualize the ocular lesions due to the different varieties of dysentery. The authors discuss the clinical aspect of the ocular lesions occurring in bacillary dysentery and their pathogenesis. Scleroconjunctivitis is the most common lesion. This condition often appears with lesions of the joints and has its onset late, from ten to twenty days after intestinal symptoms have appeared, and in cases of mild involvement even after these symptoms have cleared. It is self limited, treatment as a rule being unnecessary. Iritis and cyclitis are much more rare and occur later than conjunctivitis (in from twenty to forty days). The authors report a case in detail. Other complications which have been reported include corneal ulcer, serpiginous ulcer, motor paralysis, choroidal hemorrhages and dacryoadenitis. Three hypotheses, i. e., the direct action of the dysentery bacillus, the effect of toxin and the effect of secondary infection, have been proposed to account for these complications.

S. B. MARLOW.

Glaucoma

EXFOLIATION OF THE SUPERFICIAL LAYER OF THE LENS CAPSULE (VOGT) AND ITS RELATION TO GLAUCOMA SIMPLEX. E. HÖRVEN, Brit. J. Ophth. 21: 625 (Dec.) 1937.

Hörven states that the clinical picture of exfoliation consists of flakes on the pupillary border, a central disk and a peripheral band on the capsule of the lens and changes in the zonule of Zinn.

The flakes never occur as an isolated phenomenon but appear together with an alteration in the capsule. The flakes are therefore of a secondary character, having originated from the surface of the capsule and having become detached spontaneously or rubbed off during the movements of the iris and deposited on the pupillary border.

The central disk has the size and shape of the pupil and is of uniform structure. The peripheral band is the most prominent feature. It lies mainly in the outer third of the distance from the anterior pole of the lens to the equator, but it may be situated elsewhere. The band is invariably present in all patients who have exfoliations.

The appearance in all cases of exfoliation is similar. According to the author, the zonular changes are of a constant nature and form an integral part of the clinical picture of exfoliation.

The fibers of the ligament are covered with scurflike flakes. Hörven has examined 150 patients with the slit lamp, all of whom had been operated on for glaucoma by iridencleisis with meridional iridotomy after the method of Holth. One hundred and twenty-eight (85.33 per cent) had typical exfoliation of the capsule of the lens. Of 43 patients with glaucoma, 40 (93 per cent) showed exfoliation before operation.

Hörven is more and more inclined to believe that exfoliation offers an excellent basis for the classification of glaucoma. Glaucoma simplex must be regarded as identical with glaucoma capsulare, while exfoliation does not occur in cases of acute glaucoma or of chronic inflammatory glaucoma. Exfoliation was found in 2 of 67 inmates of old age homes without signs of glaucoma, in 1 of 34 bodies of elderly persons in the dissecting room, in 10 of 55 patients with cataract and in 5 of 30 patients without cataract or glaucoma.

It does not seem possible to find any other explanation than that senile exfoliation of the capsule of the lens must in some way or other be the cause of the form of glaucoma which is called glaucoma simplex.

W. ZENTMAYER.

FUCHS' EPITHELIAL DYSTROPHY OF THE CORNEA AND CAPSULAR GLAUCOMA. J. MALBRÁN, *Arch. de oftal. de Buenos Aires* 12:441 (July) 1937.

In a patient who at no time showed any signs of hypertension of either eye there was observed "exfoliation of the lens capsule" (capsular glaucoma) of the right eye and "epithelial dystrophy of the cornea" (Fuchs) of the left eye.

Malbrán reviews at length the scientific knowledge in relation to these processes up to date and the connection of both with glaucoma conditions.

C. E. FINLAY.

Hygiene, Sociology, Education and History

NATIONAL POLICY ADOPTED IN A TROPICAL COUNTRY FOR THE PREVENTION OF BLINDNESS. A. F. MACCALLAN, *Brit. J. Ophth.* 22:65 (Feb.) 1938.

This article contains much interesting data concerning the causes of blindness in tropical countries, especially Egypt. The statistics concerning the ophthalmic hospitals in Egypt for 1930 show that of 838,625 patients examined the number of those blind in one or both eyes was 60,157. Conjunctivitis, primary glaucoma, cataract and endogenous iritis were the principal causes. It is particularly to be noticed that in

tropical countries blindness is much more common among the rural population than among urban dwellers. The value of the ophthalmic campaign in Egypt may be judged by the percentage of persons blind in one or both eyes who come to the hospitals and crave treatment. In 1911 the percentage of cases of blindness, including those due to cataract, was 19.2, and in 1935 it was 6. The author rightly believes that the system adopted for the ophthalmic campaign has been justified by the results.

W. ZENTMAYER.

Injuries

RARE CASE OF AN INTRAOCULAR FOREIGN BODY. J. GALLINO, *Arch. de oftal. de Buenos Aires* 12: 403 (June) 1937.

A case of a foreign body lodged in the optic disk is reported. The foreign body was observed ophthalmoscopically and localized by the Sweet method.

Gallino has found only one other similar case in the literature, that reported by von Szily, which he reproduces.

C. E. FINLAY.

INTRAOCULAR FOREIGN BODY: RETINOGRAPHIC HISTORY. J. L. PAVIA, *Arch. de oftal. de Buenos Aires* 12:433 (July) 1937.

A case of an intraocular foreign body lodged 2 prism diopters below and external to the macula is reported. Its presence was tolerated without reaction for eighteen years. The different stages in the development of the ophthalmoscopic lesion were illustrated before the Argentine Society of Ophthalmology by a series of stereoretinograms.

C. E. FINLAY.

Lids

MECHANISM AND PATHOGENIC VALUE OF VON GRAEFE'S SIGN. J. VOISIN, *Ann. d'ocul.* 174: 666 (Oct.) 1937.

The study of the movement of the upper lid in downward gaze may bring into evidence two kinds of pathologic changes. One change is rarely encountered. The author proposes to call it a paradoxical raising of the upper lid, and Fuchs, in the course of repair of certain paralysis of the third nerve, has described it under the name of the pseudo sign of von Graefe. The other change is the sign of von Graefe, which is generally looked for in cases of exophthalmic goiter. This sign, contrary to the classic opinion, may be met with in the course of syndromes in which the sympathetic nervous system is not manifestly the cause.

In order to appreciate the value of von Graefe's sign, one should first study the physiologic mechanism of the associated movements of the globe and upper lid on downward gaze, as it is this movement that determines the symptom considered. The mechanism of these movements is far from being completely solved.

The presence of von Graefe's sign permits of a diagnosis of hypertonia of the muscles of the lid, but it does not give any information as to the cause of this hypertonia.

S. H. MCKEE.

Methods of Examination

THE TESTING OF FITNESS FOR NIGHT FLYING: THE LIGHT SENSE.
C. E. FERREE and G. RAND, *Am. J. Ophth.* 20:797 (Aug.) 1937.

Ferree and Rand present the following summary:

"In determining fitness for night flying, important functions to be tested are (a) the ability to see at night and at low illumination and the effect of dark adaptation on this ability and (b) the amount and speed of dark adaptation. Of these latter functions, speed of adaptation seems to be more important than amount. The night flyer needs especially the power to change his vision quickly from the illuminated cockpit and instrument panel to the outside world and back again. Normal or better-than-normal sensitivity in light adaptation is, of course, also important. The eyes that are needed for night flying are the best of what might be called the normal group; that is, of those that have both good dark and good light vision. More important than speed and range of adaptation, however, is the place in the scale of sensitivity in which the change occurs. That is, it is quite possible that a candidate might have a good range and speed of adaptation and still a poor power to see at low illumination both at the beginning and at the end of the period of dark adaptation. Such a person would be obviously unfit for night flying. To be fit for night flying the candidate must have a normal or better-than-normal rating in power to see at low illumination at the beginning of the period of dark adaptation and throughout its entire course from beginning to end.

"Tests are described for the light minimum under light and dark adaptation and for determining the amount and speed of adaptation. A special test of fitness for night flying is also recommended which is sufficiently quick and convenient for use in routine testing and a procedure is discussed for proving the significance of the test, and for determining the critical values to be used in accepting and rejecting candidates for night flying. A suitable instrument is recommended and its advantages for making the test are briefly discussed."

W. S. REESE.

ORBITAL EMPHYSEMA AS A DIAGNOSTIC MEASURE. M. ORIBE, *Arch. de oftal. de Buenos Aires* 12:458 (July) 1937.

Having observed that the eyeball showed more distinctly in roentgenograms made in cases of fracture of the superior maxillary bone with orbital emphysema, the author conceived the possibility of using artificial orbital emphysema for diagnostic purposes in a manner similar to that with which retrorenal emphysema is used in the diagnosis of certain renal lesions.

Oribe employs a 10 cm. needle, with which he penetrates the orbit at the external palpebral angle, taking care to keep clear of the conjunctival cul-de-sac. Before he injects any air, he first draws out the piston to make sure that he has not entered a blood vessel; he then injects the air slowly at distances of 1 cm., gradually withdrawing the needle. The total amount of air injected varies from 15 to 30 cm.

He reports a case of orbital tumor in which roentgenograms were taken in Blondeau's position before and after the injection of air and in an occipital position; the tumor showed excellently after the injection.

He refers to the use of injections of air, iodized poppyseed oil 40 per cent and diodrast (Katz and Ledoux) into tenon's capsule for diagnostic purposes by different authors since 1927.

C. E. FINLAY.

Neurology

THE DIAGNOSIS OF DISTURBANCES OF THE OPTIC CHIASMA AND THE SELLA TURCICA. E. VELTER, *Arch. d'opht.* 53: 593 (Aug.) 1936.

The salient points in the diagnosis of lesions in the area of the optic chiasma and the sella turcica are briefly discussed by the author. He emphasizes, however, the necessity of recognizing the possibility that only isolated signs may be present in a given case and that if early diagnosis is to be made one should not wait for complete evidence. The lesions which occur in this area are divided into those of tumor and those due to inflammation or trauma. The intrasellar tumors consist of chromophobe adenomas, acidophilic and basophilic adenomas and craniopharyngiomas. Illustrative cases are cited. The retrosellar, or sub-sellar, tumors are composed mainly of malignant growths of the sphenoid, in which there is no characteristic hypophysial syndrome. The suprasellar tumors include the large tumors of Rathke's pouch which have extended outside the sella turcica; the meningiomas, median, lateral and anterior, and tumors of the third ventricle. Reference is made to the possible occurrence of aneurysm, cholesteatoma and gliomas. In the second group the author discusses trauma briefly. Cases of syphilitic meningitis and arachnoiditis are reported. The conclusion drawn from a diagnostic point of view is that a disease of this area is not always a tumorous condition; that drawn from a therapeutic standpoint is that radiotherapy is the treatment of choice for adenoma when it is diagnosed early. This treatment is of no value for the other lesions and may be distinctly harmful in that surgical treatment later may be more hazardous. Each form of treatment, medical, radiologic and surgical, has its indication and should not be used indifferently.

S. B. MARLOW.

HOMOLATERAL HORNER SYNDROME IN EXPERIMENTAL LESIONS OF THE OPTIC THALAMUS. A. GARCIN and M. KIPFER, *Compt. rend. Soc. de biol.* 126: 864, 1937.

Sympathetic ocular disturbances have been occasionally observed in persons with thalamic lesions. In a case recently reported, Garcin emphasized the homolaterality of the ocular phenomena. With bipolar electrolysis the authors were able to reproduce like syndromes in dogs, by means of lesions limited to the thalamic nuclei. Positive results occurred when the lesion was located between the chiasm and the mammillary tubercles, affecting particularly the anterior portion and the external nucleus of the optic thalamus. The ocular disturbances occurred tardily after a latent period of five or more days. The Horner syndrome hence can be produced independent of the hypothalamus and the cerebral peduncle.

J. E. LEBENSOHN.

SPASMUS NUTANS. G. ÖSTERBERG, *Acta ophth.* 15:457, 1937.

Spasmus nutans is an infantile disease, usually beginning at an age of from 6 to 12 months but never after the third year. The classic signs are nystagmus of the head, torticollis and nystagmus of one or of both eyes. These signs disappear during sleep. The ocular nystagmus is intensified if the head is held still. Complete recovery occurs after a couple of years. Nystagmus of the head alone may occur and is suggestive of spasmus nutans, while if ocular nystagmus is the only sign present, as it may be, care must be taken to differentiate the condition from congenital or early acquired amblyopia associated with strabismus or refractive anomalies. Labyrinthine disease must be excluded by functional tests. The author gives short reports of 4 true and of 2 spurious cases of spasmus nutans.

O. P. PERKINS.

Ocular Muscles

SITE AND NATURE OF THE PROCESS OF IMAGE INHIBITION IN CASES OF STRABISMUS. H. HARMS, *Arch. f. Ophth.* 138:149 (Oct.) 1937.

To analyze the process of image inhibition, or suppression, in cases of strabismus, two methods were used, namely, binocular perimetry and determination of the pupillomotor sensitivity of central and peripheral retinal areas. The perimetry was done principally on the Bjerrum screen, with the patient wearing a red glass over one eye and a green glass over the other eye. A large red target, which was visible to one eye as a colorless bright spot and invisible to the other eye, was used to detect scotomas in the former eye. With a white target it was determined to what extent each eye actively contributed to the binocular field. The patient, then, saw a greenish or a reddish spot if the particular area of the field was "covered" chiefly or exclusively by one eye; if both eyes were active in the particular portion of the field, the target appeared as a mixture of red and green or as two targets. In addition to this subjective method, the author used a method of objective perimetry, namely, the determination of the pupillomotor sensitivity of the retina. Through a diaphragm with central and peripheral slots arranged in the shape of an isopter, central and peripheral retinal areas of equal size were alternately illuminated and the pupillary reactions observed. By dimming the light that fell on the central retinal area, the pupillary reactions occurring on illumination of the central and peripheral retinal areas were made equal. The relation between the two intensities of light which produced equal pupillomotor effects, the so-called equipupillomotor quotient (central: peripheral intensity of light), could be determined with a fair degree of accuracy. In normal controls the quotient varied greatly but remained always smaller than 1; in patients with central scotomas due to lesions of the infrageniculate portion of the visual pathway, the quotient was greater than 1.

Patients with strabismus were tested with these two methods. Those with unilateral strabismus, amblyopia and inability to fixate usually showed in the squinting eye a central scotoma and always suppressed impressions received by the retinal area of the squinting eye which corresponded to the macula of the other (normal) eye. The latter phenomenon prevailed bilaterally, that is, in each eye of persons with

alternating strabismus and anomalous retinal correspondence. In persons with alternating strabismus and normal retinal correspondence, all impressions received by the squinting eye were inhibited. In persons with central scotoma the equipupillomotor quotient was greater than 1, a fact which indicated that the pupillomotor sensitivity of the retina in the central region was also reduced. This parallelism between sensory and pupillomotor sensitivity suggests that the process of image inhibition in cases of strabismus takes place in the infrageniculate portion of the visual pathway. Since the inhibition is never hemianoptic, the process must be infrachiasmal. In the infrachiasmal portion of the visual pathway only the retina contains ganglion cells and therefore is the logical site of the process of image inhibition. The accuracy with which the inhibition takes place in each eye simultaneously or alternately justifies the assumption of a central control (probably by the suprachiasmatic center) of the peripheral inhibitional process.

Amblyopia ex anopsia is not the result of an anopsia but constitutes, according to Harms, the most severe and permanent form of image inhibition in cases of strabismus. All the sensory peculiarities which have been described in cases of strabismus are phenomena of adjustment to the abnormal position of the eyes and can, therefore, not be the cause of strabismus.

P. C. KRONFELD.

Operations

FROM OPTICAL TRANSPLANTATION TO THE TREATMENT OF KERATITIS AND CERTAIN CUTANEOUS DISEASES BY TISSUE TRANSPLANTATION.
V. P. FILATOV, *Vestnik oftal.* 11:295, 1937.

This article lends itself to abstracting with difficulty. The basis for clearing of the corneal transplant and also the action of additional keratoplasty on the opaque transplant are discussed in detail. Cases of tuberculous, herpetic, pannus and interstitial syphilitic keratitis are reported in which additional keratoplasty favorably influenced the inflammatory process of the cornea. Photographs of 6 patients are presented to illustrate the marked improvement in the cornea after the operation. Filatov believes that additional transplantation stimulates and increases the resistance of the corneal cells to the inflammatory agent and that a biochemical process of an autocatalytic nature takes place in these cells. The treatment of keratitis by transplantation is successful when both the tissue of the host and that of the guest are of the same histologic and zoologic type.

Based on this fact, Filatov made an attempt to treat lupus vulgaris of the skin by transplantation of the skin of a cadaver. Since it can be preserved for several days, Filatov believes that it has an advantage over "fresh" skin, as it will not absorb as quickly as the former. Three cases are reported in which the skin of a cadaver was transplanted on patients with lupus vulgaris of the face, nose and hands and in which the transplant "took" and acquired elasticity. Thus Filatov believes that homoplastic transplantation of various conserved tissues of the corresponding histologic type is a powerful therapeutic agent but that in general this treatment requires further study. Photographs accompany the case reports.

O. SITCHEVSKA.

Orbit, Eyeball and Accessory Sinuses

PARASITIC PSEUDOTUMORS OF THE ORBIT. C. PASCHAFF, Arch. d'ophth. 53: 657 (Sept.) 1936.

Parasites invading the orbit produce two kinds of pathologic reactions: inflammatory, leading to suppuration, and neoplastic, such as pseudotumors. In a section on orbital tumors due to zooparasites the author discusses the lesions produced by Protozoa and by the platyhelminths and nemathelminths. A case of syphilitic gumma is cited to illustrate the first type of lesion, and a case of echinococcosis and 2 unusual cases of cysticercosis, to illustrate the second type, reference being made to trichinosis and filariasis as examples of infection due to nemathelminths. In a second section dealing with orbital tumors due to phytoparasites a case of symmetric tuberculoma is presented to illustrate a subgroup of bacterial pseudotumors, and a case of actinomycosis, to illustrate orbital infection due to Discomyces. In the latter case the author found an organism not unlike *Streptothrix farcinica bovis*, for which he suggests the term *Streptothrix actinomyces*. The interest in such cases lies in the fact that the condition tends to engulf the optic nerve and produce atrophy. Surgical extirpation has been successful in some instances.

S. B. MARLOW.

OPHTHALMIC SEQUELS OF THE RADICAL CURE OF FRONTOETHMOID SINUSITIS. P. HALBRON, Arch. d'ophth. 53: 861 (Dec.) 1936.

This report is based on a study of 48 patients operated on for frontoethmoid sinusitis or pansinusitis. Classically the motor defect which results is involvement of the superior oblique muscle, but a study of the cases presented here indicate that other muscles may be affected. At least six months should elapse before surgical correction is attempted, as many patients recover without it. The principal lacrimal complication is epiphora, which often clears with the subsidence of the subcutaneous inflammation. Edema of the lids is frequent. Sometimes abscesses occur. Although purulent conjunctivitis is seldom seen, corneal disturbances have been observed. Such disturbances seem to arise from defective bandaging, which leaves the eye uncovered. In most instances closure of the lids results in cure in a few days. As a result of this study, the author points out that when an operation is done the incision must avoid the lacrimal sac, that care must be taken not to injure the pulley, and that after operation a dressing which closes the lids should be applied.

S. B. MARLOW.

Retina and Optic Nerve

RETROBULBAR NEURITIS IN CASES OF SEROUS MENINGITIS. E. PUSCARIU, Brit. J. Ophth. 21: 599 (Nov.) 1937.

Of 10 cases of retrobulbar neuritis, in 2 that condition was associated with serous meningitis.

The first case was that of a woman aged 23, who lost her sight in four days, after marked orbital and ocular pains. The blindness persisted fifteen days and receded somewhat at the moment of admission

to the clinic, when the patient was able to count fingers at 20 cm. with the right eye and at 40 cm. with the left eye. The visual field of the right eye could not be explored. There were a central scotoma in the left eye and decolorization of the nasal half of the optic disk. The Wassermann reaction of the blood was positive, and there was a slight rachidian hypertension. The spinal fluid was normal, except for a positive Wassermann reaction. After protein therapy and antisyphilitic therapy, sight was gradually restored, reaching $\frac{2}{3}$ in the left eye and 1 in the right eye after four months, with disappearance of the central scotoma. The spinal fluid contained only 6 lymphocytes. The punctures were always well supported.

The second case was one of retrobulbar optic neuritis in a youth aged 19. He admitted a certain excessive use of tobacco and alcohol. At the beginning no signs of the disease were present ophthalmoscopically. From Jan. 4, 1933, to Feb. 28, 1934, seven lumbar punctures were done. The lumbar tension (with the patient seated) varied between 50 and 80 cm., except at the last examination, when it was only 25 cm. Chemical and cytologic examinations did not reveal any abnormality. The punctures were in general well supported and gave some relief. On admission to the clinic the patient could count fingers at 60 cm. with the right eye and at 1 meter with the left eye. Vision improved at the last examination to $\frac{1}{8}$ in the right eye and $\frac{1}{6}$ in the left eye. The visual fields for red and green were restored, and the central scotomas were much reduced.

The practical conclusion to be drawn from the author's observations is that in dealing with retrobulbar neuritis one should think also of serous meningitis and practice lumbar puncture. In addition to its diagnostic value, this procedure affects favorably both the general cerebral symptoms and the ocular manifestations.

W. ZENTMAYER.

GRÖNBLAD-STRANDBERG SYNDROME (ANGIOID STREAKS OF THE RETINA AND PSEUDOXANTHOMA ELASTICUM) AND ITS RELATION TO DISEASES OF MESENCHYMAL TISSUES. A. FRANCESCHETTI and E. L. ROULET, *Arch. d'opht.* 53:401 (June) 1936.

The authors conclude that from the ocular standpoint this syndrome is characterized by lesions which are encountered in mesenchymal tissues in general. Two cases are reported in detail and the literature is reviewed to lend support to this idea. In the first case there were typical ocular and cutaneous changes, which are illustrated by photographs and colored drawings of the fundi. The patient's parents were consanguineous. In the second case the picture of the fundus was characteristic, but there were no cutaneous manifestations. Diabetes was present. The authors suggest that the name syndrome of Grönblad and Strandberg makes it possible to include under this condition those cases in which there is pseudoxanthoma with chorioretinal changes but no angioid streaks as well as those cases in which angioid streaks are present but pseudoxanthoma is lacking. They point out that there is some reason for believing that this condition is hereditary and recessive in type. Reference is made to theories proposed to account for the changes present. Tuberculosis as a provocative factor, Paget's disease,

Osler's disease and the occurrence of hemorrhages are all considered. The authors believe that diabetes is more commonly present than has been reported. A 6 page bibliography is appended.

S. B. MARLOW.

RECURRENT RETINOVITREOUS HEMORRHAGES IN THE YOUNG. P. BONNET, L. PAUFIQUE and L. SARRAZIN, Arch. d'opht. 53:849 (Dec.) 1936.

The authors first review historically the reports which have been published on this condition and briefly discuss the etiologic factors suggested. The question as to whether the hemorrhages are due to diapedesis or rupture of a vessel is raised. Bonnet, himself, favors the idea of a slow breaking of the wall of the vessel. The question of tuberculous periphlebitis is discussed in relation to it. A case is described in which changes were observed ophthalmoscopically prior to the appearance of hemorrhage, forecasting the hemorrhage, and at the time of the hemorrhage. The late results of the hemorrhage were also noted. Colored plates illustrate the case report. Active tuberculosis was shown to be present clinically and bacteriologically. After extensive hemorrhage into vitreous had cleared, definite areas of periphlebitis were found and are depicted. While many causes for this condition can properly be considered, most important is the presentation of complete clinical or anatomic observations made in cases of this kind.

S. B. MARLOW.

RETINITIS CIRCINATA IN A HIGHLY DEVELOPED STAGE: REPORT OF A CASE. M. HANDMANN, Klin. Monatsbl. f. Augenh. 98:618 (May) 1937.

Handmann reports a case of retinitis circinata in a woman aged 49. He observed the patient for five years, from the initial stage to the development of an extensive white degenerated area in the retina. The patient was otherwise perfectly healthy. The condition in the eye represented the final stage of retinitis circinata, if based on Fuchs' first description, because the appearance of the retina deviated in many respects from that in exudative retinitis. The diagnosis could be ascertained because the process was observed clinically from the beginning to the end. This case proves again that retinitis circinata which is not associated with any complications may lead to extensive massed exudations in the posterior layers of the retina in the course of several years.

K. L. STOLL.

ROENTGEN THERAPY OF RETINAL GLIOMA. H. SCHEYHING, Klin. Monatsbl. f. Augenh. 98:756 (June) 1937.

The right eye of a boy aged 4 was enucleated for glioma, and the preoperative diagnosis was corroborated by histologic examination in November 1927. Shortly afterward the left eye was treated with roentgen irradiation. Vision was 5/5 in the beginning of 1931, but radial opacities in the lens were observed by the end of that year. The

cataract was extracted by another oculist in 1935, and a dissection of a secondary cataract was performed by the author in December 1936. Illustrations show the difference in the appearance of the fundus in 1931 and in February 1937. The tumor, located above the disk, was greatly reduced and showed deposits of lime. Scheyhing was surprised to observe atrophy of the choroid surrounding the tumor and extending into the region of the macula; he considers it as a lesion due possibly to irradiation.

Four questions of importance are answered by the author in connection with this case. The diagnosis of glioma was confirmed by the histologic examination of the right eye and by the ophthalmoscopic examination of the left eye. Recovery actually occurred, as no recurrence was observed within ten years after roentgen irradiation. A case of the same duration of observation was reported by Heine.

It is impossible to decide whether recovery was the result of irradiation or if it occurred spontaneously, as reported by a number of authors in whose cases the eyeball remained unaltered and vision was preserved. Scheyhing thinks that a glioma as small as that observed in the left eye of his patient may have offered a tendency for spontaneous recovery but that this tendency may have been stimulated by irradiation. Detrimental lesions as a result of irradiation were not observed, but slight changes in the conjunctiva and the cataract developed. The child received small doses, of from 30 to 50 per cent, during the first two years of his treatment, and two large doses, of 80 and 100 per cent, respectively, during the third and last year.

K. L. STOLL.

REPORT OF A CASE OF VERY REMARKABLE VASCULAR CHANGES IN THE FUNDUS. T. KIKKAWA, *Acta soc. ophth. jap.* 39: 16 (Feb.) 1935.

Takayasu in 1908, Nakajima in 1921 and Uchino in 1930 reported cases of this unusual alteration of the retinal vessels, though the condition has not been formulated as an independent disease picture. These cases showed in addition other anomalies of the circulatory apparatus. In the case reported, that of a girl 19 years of age, the changes were as follows: The condition occurred in both eyes. It was accompanied by marked diminution of vision and terminated in cataract. The numerous looplike communications between the arterial and venous blood vessels of the retina were rounded, fusiform or cylindric dilatations of the vessels, forming a ring around the disk, without inflammatory symptoms. The other circulatory anomalies were absence of the arterial pulse, the impossibility of measuring the blood pressure, and a bruit over the jugular vein.

A. KNAPP.

Trachoma

CULTURE OF RICKETTSIAS OF TRACHOMA IN VITRO. POLEFF, *Arch. d'opht.* 53: 882 (Dec.) 1936.

The author describes in detail the methods used in culturing trachomatous tissue. By this method he has been able to isolate and culture rickettsias of trachoma and to carry the organisms through five transplants. Some evidence is put forward to show the close relation

between these rickettsias and the inclusion bodies of Prowazek and Halberstaedter. The author leaves the etiologic and specific nature of these organisms for further consideration until more immunologic experiments have been completed.

L. B. MARLOW.

AUTOHEMOTHERAPY FOR TRACHOMATOUS PANNUS. B. P. LERNER, *Vestnik oftal.* 10: 841, 1937.

Thirty-eight patients suffering from trachomatous pannus were treated by autohemotherapy. For fourteen of these, this treatment was combined with local therapy (the use of atropine or silver nitrate, expression, etc.). A subcutaneous injection of 10 cc. of blood was given every other day, until fifteen injections had been given. In cases of recent pannus, infiltrates or ulcers of the cornea, both the combined therapy and autohemotherapy alone gave good results, but there was little response to the treatment in cases of long-standing pannus.

O. SITCHEVSKA.

Tumors

CONCERNING CONDITIONS SIMULATING AN INTRAOCULAR TUMOR. B. A. KLIEN, *Am. J. Ophth.* 20: 812 (Aug.) 1937.

Klien reports the clinical findings and pathologic changes in 4 cases of a condition simulating intraocular tumor and gives the following summary and conclusions:

"In three different conditions suspicion of an intraocular new growth was raised by the following clinical symptoms: 1. A more or less extensive retinal detachment. 2. A rise in intraocular tension that could not be controlled by medication and that in two of three eyes had a fluctuating character. 3. Circumscribed, poor transillumination of the eyeball in one or more places in three of the eyes. 4. The discovery of rigid, circumscribed, dark-appearing elevations which could not be interpreted correctly in two eyes in which the fundus was visible.

"In regard to the first symptom, the retinal detachment was twice due to Coats's disease, once it followed a small disinsertion of the retina in an apparently slightly myopic eye, and once it was preceded by a spontaneous choroidal detachment.

"As to the second symptom, the secondary glaucoma that was present in three of the four eyes was due to an obstruction of the chamber angle, consisting of iritic adhesions in two eyes. In the third eye, which had a wide-open angle, it was possibly due to the nature of the exudate that blocked the spaces of Fontana temporarily between the hypotonic periods.

"In connection with the third symptom, the areas of poor transillumination in one of the eyes corresponded to histologically found areas of hemorrhage in retina and vitreous. The dullness in the two other eyes may have been due to partial dispersion of the penetrating rays by the smooth, round posterior surface of the cyst and the equally smooth, pigmented and rigid, curved surfaces of the choroidal detachment.

"Finally, the dark appearance of the circumscribed elevations ophthalmoscopically was an optical phenomenon in the eye with the large cyst and due to the pigment epithelium of retina and ciliary body in the eye with the choroidal detachment.

"I do not wish to give the impression that the enucleation of any of these eyes should or could have been avoided. Once a secondary glaucoma complicates the conditions just demonstrated, the prognosis as to keeping a useful or comfortable eye is poor, and once a clinically well-founded suspicion of an intraocular growth has arisen, the eye is best removed."

W. S. REESE.

Uvea

SUBCHRONIC UVEOPAROTITIS (HEERFORDT). C. WESKAMP and E. ADROGUÉ, *Arch. de oftal. de Buenos Aires* 12:319 (June) 1937.

After a few short and pertinent remarks on uveoparotitis, a case of Heerfordt's subchronic uveoparotitis (*febris uveoparotidea subchronica*) is reported. No hereditary or personal data with bearing on the disease in question were obtainable.

The patient was first seen by the authors in 1935. In 1929 he suffered from severe pain in the lumbar region, with pain in the testicles and swelling of the parotid glands. A diagnosis of mild parotitis, orchitis on the left side and pancreatitis was made. Symptomatic treatment was given. A year later the symptoms reappeared, lasting for seven years, with remissions. The symptoms consisted mostly of headaches (occipital), which were brought on by any undue effort or by psychic excitement, occurring sometimes several times a day and at others only every three or four days. Visual disturbances commenced in 1930, at first in the form of a central scotoma in the right eye, and gradually progressed to total loss of sight; later, visual disturbances appeared also in the left eye. Ophthalmoscopic examination showed the lesion in the right eye to consist of atrophy of the optic nerve with white subretinal masses; in places there was disappearance of the retinal pigment, with baring of sclerosed choroidal vessels. The diagnosis was proliferating, chorioretinitis subsequent to an original exudative choroiditis. In the left eye there were peripheral pigmentary changes, with narrowing of the visual field similar to that seen in retinitis pigmentosa.

Treatment with arsenicals, diathermy, tuberculin and other measures was entirely unsuccessful.

C. E. FINLAY.

Vitreous

TRAUMATIC SACKLIKE HERNIA OF THE VITREOUS INTO THE ANTERIOR CHAMBER AND CONSIDERATION OF THE LIMITING MEMBRANE OF THE VITREOUS. B. PAULA-SANTOS, *Arch. d'opht.* 53:876 (Dec.) 1936.

Prolapse of the vitreous into the anterior chamber takes place in two forms: the laminated, which is the most common, and the saccular. The author reports in detail a case of the latter type. Hess reported 6 similar cases in 1919 and was able to find only 2 other cases reported

in the literature up to that time. The author has found only 2 cases since 1920, making a total of 11. Haitz has suggested that in the first type the limiting membrane of the vitreous is ruptured, while in the second it is not. If Haitz's theory is correct it means that the hyaloid membrane is elastic. If this is so, the hernia of the vitreous should retract. The author suggests that the hyaloid membrane is ruptured in these cases at first and that a secondary membrane is formed about the hernia.

S. B. MARLOW.

DETACHMENT OF THE VITREOUS. V. ČAVKA, Arch. f. Ophth. 137: 472 (Aug.) 1937.

Čavka describes one case of anterior and posterior detachment of the vitreous combined with other degenerative changes of the vitreous in an 8 year old patient with high myopia and a case of posterior detachment of the vitreous with formation of a hole in the hyaloid membrane following optic neuritis. For the study of the vitreous with the slit lamp he uses the contact glass of Koeppe and Koeppe's special corneal microscope, which is equipped with only one objective.

P. C. KRONFELD.

Therapeutics

ROENTGEN THERAPY IN TUBERCULOSIS OF THE ANTERIOR SEGMENT OF THE EYE. A. SUKONSTCHIKOVA and D. LUKIN, Vestnik oftal. 11: 378, 1937.

The authors began using roentgen therapy (80 kilovolts in the secondary chain, 2 milliamperes and a 3 mm. aluminum filter) for diseases of the anterior segment of the eye in 1933. Up to date this treatment has been used in 2 cases of trachomatous pannus, 13 of tuberculous interstitial keratitis, 2 of keratoiritis, 13 of keratoscleritis, 17 of episcleritis and 3 of scleritis, making a total of 50 cases. All patients were affected by a severe recurrent process, for which no other treatment gave favorable results. The majority of the patients received from four to six treatments at weekly intervals. In a few instances the therapy had to be discontinued after the first treatment because of a severe reaction. An improvement was usually noticed after the second treatment.

The authors arrive at the following conclusions:

1. Roentgen therapy in the treatment of tuberculous diseases of the anterior segment of the eye is one of the most effective remedies.
2. The absorption of the tuberculous process occurs in a short time.
3. The treatment is most effective in cases of keratoscleritis.
4. The nodules in the sclera and episclera absorb completely without leaving scars.
5. Small doses, 10 per cent of a unit skin dose, or 60 roentgens, are preferable for insurance against late complications.

O. SITCHEVSKA.

Society Transactions

EDITED BY W. L. BENEDICT

NEW YORK ACADEMY OF MEDICINE, SECTION OF OPHTHALMOLOGY

JAMES W. WHITE, M.D., *Chairman*

Nov. 15, 1937

RUDOLF AEBLI, M.D., *Secretary*

MICROPHTHALMOS WITH THE FORMATION OF A CYST. DR. DONALD W. BOGART.

M. P. G., a boy 5 months of age, was admitted to the New York Eye and Ear Infirmary on Aug. 23, 1937, having been referred by Dr. Francis Shine. The child had been delivered normally, and after its birth it was noted that the right eye was apparently absent. In two weeks a "fleshlike" lump could be seen protruding through the palpebral fissure; it remained unchanged until the patient was seen. No other anomalies were noted. There was no history of consanguinity. A sister of the patient had a small eye with a coloboma of the iris and choroid and only light projection.

At the age of 5 months the child appeared to be normal and had an apparently normal left eye. The right eye was not present, being replaced by a mass of tissue within normal lids and foreshortened conjunctiva, from which protruded a bluish red cystic mass 1 cm. in diameter, which was semisoft and movable. The lids could be closed over the cystic mass. Roentgenograms of the skull and right orbit showed no abnormalities.

The baby was operated on under general anesthesia. The cyst and orbital contents were removed en bloc. Recovery was uneventful.

The sections disclosed a microphthalmic eye with a connected cyst, following the classic description. The walls of the cyst were composed of two coats: an outer fibrous one, continuous with the sclera, and an inner one, which consisted of more or less developed retina.

This condition shows distinct hereditary trends. Microphthalmic eyes may be divided into two classes: (1) those with no apparent congenital defect except the smallness of the globe and (2) those in which there is, in addition to smallness, an abnormality resulting from imperfect closure of the fetal fissure, as in this case.

DISCUSSION

DR. MORRIS ROSENBAUM: In 1931 I published a report of a case of bilateral anophthalmos. Dr. Doherty, who performed the operation at the Bellevue Hospital, never succeeded in finding any vestige of an eye. In 1936 I published the report of a case of unilateral microphthalmos with a cystic formation. In this case I enucleated the eye, and while I felt the cyst before the operation, when I took the eye out it was not

present; evidently it was so thin walled that it broke at the time of operation. In examining that eye I found degenerative changes, mostly bone formation, in the vitreous.

It is interesting to speculate as to the causation of anophthalmos and microphthalmos associated with a cystic formation. There are various theories concerning the formation of the cysts, and various experiments have been made by Ochi and Fred Hale. Hale published an article in 1935 wherein he reported anophthalmos in pigs from gilts maintained on a diet deficient in vitamin A. Ochi experimented on chicks with roentgen rays and other toxic substances and produced anophthalmos. In some of these cases I think the condition is due not only to vitamin A deficiency but to chromosome deficiency. When there is a chromosome deficiency somewhere in the gene, a maldevelopment occurs, either anophthalmos or microphthalmos, with cysts. Other causes may be hemorrhage during the fetal growth, amniotic strands or toxic substance.

COATS' DISEASE. DR. ROBERT M. OLIVER.

External deviation of the left eye and a normal right eye were found in an 8 year old boy. The vision in the left eye was 20/200. The disk was congested and indistinct. The nasal portion of the fundus was normal, and the remainder of the fundus presented white hyperplastic organizations, resembling popcorn, over which the retinal vessels followed the contour of each ridge and depression.

CONJUNCTIVITIS TULARENSIS. DR. DAVID H. WEBSTER.

This report will be published in full in a later issue of the ARCHIVES.

SARCOMA OF EYELID. DR. FRITZ BLOCH.

In a seaman 63 years old, who was otherwise healthy, two small tumors, about the size of small pears, developed twelve months previous to examination. The growths were covered with purplish ulcerated conjunctiva, giving the impression of granulating chalazions. The histologic examination showed mixed cell sarcoma originating in the tarsus.

CHORODIAL SCLEROSIS IN CORONARY ARTERIOSCLEROSIS. DR. MARTIN COHEN.

This paper was published in full in the April 1938 issue of the ARCHIVES, page 487.

JAMES W. WHITE, M.D., *Chairman*

Dec. 20, 1937

RUDOLF AEBLI, M.D., *Secretary*

RING SARCOMA: REPORT OF A CASE. DR. CLYDE E. McDANNALD.

An Italian woman aged 24 was first seen on Feb. 9, 1935, having been referred from the office of Dr. Wilnot Allen. She gave a history of having had heterochromia since birth. The vision was reported to be

normal until six months prior to examination, at which time blurred vision and some inflammatory symptoms developed.

On examination the right eye was normal in every respect, and vision was 20/20 +. The vision in the left eye was 20/30; the cornea was clear, the anterior chamber was deep, and marked heterochromia of the iris was present. The pupil was mobile except from 7 to 9 o'clock, where it was definitely thickened. In this area, on the nasal side, considerable vascularization was present, and an apron of uveal pigment extended from the pigmented margin of the pupil over the iris. On transillumination the infiltrated area showed some thickening but no protrusion back of the iris. The media were clear, and the optic nerve showed marked glaucomatous cupping, with a small hemorrhage on the nasal side. The tension was 50 mm. of mercury (Schiötz). The Wassermann reaction was negative, and roentgenographic examination gave negative results.

The patient has been followed closely at monthly intervals up to the present time. The intraocular tension was only partially controlled by the use of pilocarpine hydrochloride, and in August 1935 the vision for the first time had notably diminished to 20/65. In the meantime the lesion had not changed except for increased vascularization and some enlargement of the apron of pigment.

The visual fields taken at intervals showed a progressive loss in the lower nasal quadrant. By February 1937 the vision had dropped to 20/200 +. There was no appreciable change in the appearance of the lesion. By August 1937 the vision had been further reduced to ability to count fingers at 10 inches (25 cm.), and the nerve head was completely cupped and showed a typical glaucomatous atrophy.

In November 1937, though the external appearance had not materially changed, transillumination disclosed a small papillary protrusion behind the iris extending from 7 to 8 o'clock, and the iridocorneal angle was completely blocked with pigmented tissue.

At the present time, the vision is limited to preception of hand movements, and the iris is depigmented and atrophic. The pupil is eccentric toward the nasal side, and uveal ectropion forms an apron extending from the pupillary margin to the angle, where the iris tissue is replaced by a vascularized, slightly grayish, fleshy mass.

DISCUSSION

DR. TRUMAN L. BOYES: In 1927 Dr. McDannald and I had the opportunity of examining a patient 62 years of age who previous to that time had normal vision in each eye. The pupil of the left eye was slightly pear shaped, and she stated that it had been so for two years. A year later Dr. McDannald saw her again. He presented her before the New York Ophthalmological Society, where it was agreed that the eye should be kept under observation. The following year, in 1929, the intraocular tension was increased. There was a growth in the iris and ectropion of the uvea from 4 to 6 o'clock, where the iris had become thickened. The tension was elevated to 60 mm. of mercury when Dr. McDannald presented the patient a second time before the society. The consensus then was that the eye should be removed. That was four years after the first examination. The sections showed a sarcoma of the iris and ciliary body.

DR. MARK SCHOENBERG: I should like to ask whether roentgenograms have revealed metastases in some other part of this patient's body and if the urine contains melanin.

DR. CLYDE E. McDANNALD: The patient has not had a general roentgenographic examination. I plan to have that done, and I am checking up on the Wassermann reaction. When the patient was first seen she had a negative Wassermann reaction.

NOTE.—The left eye was enucleated on March 2, 1938. The diagnosis was confirmed.

ETIOLOGY AND TREATMENT OF KERATOCONUS. DR. ARTHUR ALEXANDER KNAPP.

This report on the causation, pathologic process and treatment of keratoconus is based on two sets of observations: (1) animal experimentation, in which pathologic examinations of the affected eyes were made, and (2) the improvement observed in man after the indicated therapy had been given.

In a previous paper, from the College of Physicians and Surgeons, Columbia University, the department of pharmacology, Blackberg and I reported the consistent production of keratoconus in dogs fed a diet deficient in vitamin D and low in calcium. In a more recent paper, we published a report on the pathologic process in the fibrous tunic of the affected eyes. (These pathologic changes were reviewed with the aid of slides.)

Twelve patients with keratoconus are included in the present study. Eight are present for examination by members of the section, and 1 is shown so that the condition of his right cornea may be noted before the institution of therapy. The remaining 11 patients have been treated for periods ranging from three months to three years. Various degrees of involvement of the cornea are present. Plaster casts of several conical corneas before and after treatment are on display.

The treatment consisted of vitamin D, in the form of viosterol (10,000 units of vitamin D per gram), and calcium, in the form of mineral mixture tablets composed of alfalfa ash, dicalcium phosphate and edible bone meal.

The subjective and objective improvement have been studied. (Slides were shown depicting this phase of the study.) To gage the objective improvement, plaster casts, retinoscopic examination under cycloplegia and microscopic and macroscopic examinations of the cornea have been utilized. Measurements of the molds were made by Professor De Zafra, of the engineering department of New York University. Without exception, all of the patients who were treated improved; the cones were flattened.

A further study is being made.

DISCUSSION

PROF. CARLOS DE ZAFRA: In order to measure the plaster cast molds, a "toolmakers' microscope" was used. At the College of Engineering of New York University is located the precision measurement and gage checking laboratory of the United States War Department, where a

number of instruments for various precision measurements are available. When Dr. Knapp first came to me, the problem was to mount these plaster casts so as to get the desired measurements. First we tried projecting them against a screen with a screw thread comparator, but owing to the narrowness of the light beam the shadow on the screen did not represent the full width of the cast; so we resorted to a toolmakers' microscope, the table of which is represented in the accompanying illustration. To this table (*A*), which is mounted on ball bearings, are attached two micrometers, *M* and *M*₁, graduated in ten-thousandths of an inch, for measuring lateral and longitudinal movement of the table.

Back of the center of the table was a Hoke precision gage block, *B*, of dimensions given by Dr. Knapp according to the diameter of the specimen to be examined. A gage makers' precision square, *CC*, was used to line up the gage block with the axes of the table. Touching this gage block was a plaster cast, *D*, making contact as at *O*. When one

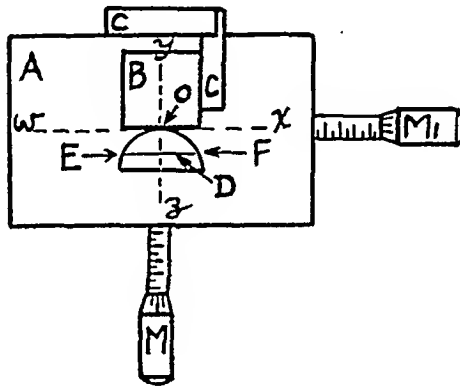


Diagram of the table of a toolmakers' microscope

looked through the microscope, the cross hairs, *wx* and *yz*, were brought in coincidence at *O*, the point of tangency of the plaster cast and the gage block. A reading on micrometer *M* was then recorded, which became the basic, or reference, measurement. Then the intersection of the cross hairs was made coincident with the point *E* of the plaster cast. The difference between the measurement here recorded and the basic measurement represented the height of the apex. However, because of the difficulty of placing the plaster cast with certainty that the circle diameter *EF* was absolutely parallel with the reference surface of the gage block *B*, the cross hairs of the microscope were similarly brought in coincidence with the point *F* of the circle, and the measurement thus indicated on micrometer *M* was deducted from the basic measurement and the height of the apex again determined. By virtue of the fineness of the measurements (to the ten-thousandth part of an inch), any inaccuracy in setting the circle line or diameter *EF* parallel to the face of the gage block was corrected by taking the mean of the two readings. This figure, in decimals of an inch, is readily convertible into millimeters by multiplying by the conversion factor 25.4.

CONTRAST MEDIUMS IN ORBITAL ROENTGENOGRAPHY. DR. MURRY A. LAST.

This preliminary report is based on an investigation of the use of air injected into the orbits for roentgenographic and fluoroscopic studies of normal and pathologic structures, including foreign bodies. Stereoscopic pneumograms showed the outlines of the displaced globes, the accessory structures and dense shadows which corresponded to neoplasms, the presence of which was later confirmed by operation. These growths included an epithelial cyst, a myxofibrosarcoma and a thyrogenic metastatic tumor of the orbit. An inflammatory pseudotumor in which the orbital vessels showed an almost complete endarteritic obliteration was revealed in the roentgenograms of the orbit after the injection of air as a diffuse density about the globe. In all these cases roentgenograms made by the usual methods were reported to be normal.

The technic is simple. By means of a sterile syringe, air is introduced through the lids into the deep orbital fat, the normal structures and areas thought to be pathologic being avoided. The use of repeated aspirations to avoid embolic phenomena, the slow introduction of the air to avoid pain and injection of a sufficient amount of air to obtain a marked emphysematous proptosis are important. No untoward symptoms were present.

Carbon dioxide or oxygen may be used. Colloidal thorium dioxide should not be used because of its poor diffusibility, its retention and its radiant powers. Iodized poppyseed oil 40 per cent causes fibrosis and was not employed in this study.

Microscopic sections of the fibrosarcoma showed ocular changes resulting from localized pressure, which had caused inward bulging and corrugation folds of the retina.

THE LYMPHATICS OF THE ORBIT. DR. O. V. BATSON.

The lymphatic drainage of the lids, the conjunctiva and the lacrimal gland has been carefully studied, and the various investigators are in substantial agreement as to the anatomic structure. In a general way, the regional lymph glands for these structures are either in the area about the parotid gland or in the area about the submaxillary salivary gland. The rich lymph capillary plexuses of the lids and conjunctiva near the inner canthus, the medial fourth of the upper lid and the medial three fourths of the lower lid drain into collectors, which drain to the submaxillary region. The remaining portions of the lids and of the conjunctiva, together with the lacrimal gland, contain networks which drain to the region of the parotid gland.

It has been shown by a number of workers that material experimentally deposited in the subarachnoid space of the brain will travel out of the cranium along the optic nerve sheath as far as the globe. This extent and limitation of travel are in accord with the microscopic anatomic structure of the nerve sheath and the subarachnoid space.

There has been much doubt expressed as to the presence of true lymphatics within the globe or in the retroglobal tissues. The major evidence is against their presence. Nuel and Benoit in 1899 were able to demonstrate ink granules in the iris after the injection of ink into the anterior chamber of the eye. Definite channels were not demonstrated, however.

It was hoped that some of the roentgen opaque materials might offer a method of investigating this problem. Colloidal thorium dioxide when injected intradermally may be followed to the regional lymph nodes in roentgenograms taken a few moments later. Iodized oils injected into the pleural cavity can be seen in the mediastinal lymphatic and nodes within a few hours.

Repeated injections were made behind the globe in a series of dogs. Iodized oil and colloidal thorium dioxide were used. After an initial period of edema and capillary injection, the tissues regained their normal appearance. The roentgenograms showed that the injected material distributed itself along the muscles and became rather generally disseminated in the orbit. At no time could lymphatic shadows be made out in the roentgenogram. Roentgenographic examination of the spleen and liver in the intact animal and in the excised specimens showed no increased densities.

In animals observed for a period of several weeks, densities were seen to appear in lymph glands lying in the neck along the carotid artery. No connecting channels could be observed. In six weeks the shadow was definite.

Injections into the anterior chamber had to be terminated because of the intense inflammatory response. No early migration of the roentgen opaque substance was seen, nor was it to be expected on a basis of the structure of the parts.

These experimental injections tend to confirm the view that true lymphatics do not exist in the orbital tissues. The slow appearance of the injected material in the lymph nodes of the neck is no doubt due to the migration to the regional lymphatic glands of wandering cells loaded with thorium dioxide.

Book Reviews

The Science of Seeing. By Matthew Luckiesh, D.Sc., D.E., and Frank E. Moss, E.E. Price, \$6. Pp. 548, including index. New York: D. Van Nostrand Co., Inc., 1937.

This work is a detailed exposition of a relatively new science, which the authors choose to call the "science of seeing." They make a distinction at the outset between the "science of vision" as practiced by the ophthalmologist, limiting it largely to the correction of optical and muscular anomalies, and the "science of seeing," which takes in all the complex elements involved in the use of visual sense. These include primarily the factors of lighting, but also other elements, such as speed, accuracy and ease of seeing, the causes of general and special fatigue and work efficiency.

The whole subject is treated more from the standpoint of the illuminating engineer, and emphasis is placed on the study of man as a "seeing machine." This term and concept predominates throughout. The authors elaborate on the premise that prolonged near work and reduced inadequate (indoor) illumination are the twin curses of modern civilization. They then proceed at great length to prove their premise by biologic considerations, philosophic deductions and the results of extensive experimental work. They produced a number of ingenious devices for experimental work on the act of seeing. Their experiments embraced studies on the various aspects of light and lighting, effects of contrasts, pupillary size and reactions, changes in accommodative and convergence amplitudes, the rate of blinking and even changes in the heart rate. The results are presented in numerous tables, graphs, equations and statistical reports.

They make out a fairly good case for their contention that the general level of illumination prevalent at present is much too low for the optimum efficiency and comfort of the "human seeing machine." Adopting the term "humanitarian foot candles" for illumination, which in addition to providing adequate light for efficient seeing is also conducive to visual and bodily ease, they claim "that at least 100 ft. candles are desirable for reading under usual conditions," and for this they advocate a system of general lighting plus supplementary lighting, the general lighting to be not less than one tenth in candle power of the supplementary lighting. They arrive at these results largely from what they consider objective findings, since, as they repeatedly say, "Human beings are very poor judges of seeing conditions. They are poor seeing meters. . . ."

The authors show little respect for the ordinary findings and facts of physiologic optics, largely because these facts were obtained for the most part by subjective methods. Statements like "The common error of building an argument upon the narrow viewpoint and the incompleteness of knowledge of physiologic optics should not be made" are rather frequent.

But in their own more scientific approach they repeatedly come up against these same elements of subjective uncertainty. One can readily agree with the authors that it is best to have objective "scientific" methods of approach in the study of vision and seeing. But ultimately seeing is a complex physiopsychologic activity; as the authors themselves say, "The eyes—the visual sense—the entire human seeing machine are necessarily a part of any demonstration of seeing. The inconstancy of these factors makes it necessary to obtain many observations . . . to yield dependable results." And it may be added that these dependable results will still not be reducible to objective machine measurements. Here and there in the book there crops out a sort of undercurrent clash between the desire and the appearance of straight objective findings and the somewhat reluctant admission of the inevitable subjective elements involved.

The authors describe several instruments of their own invention, including the sensitometer. This measures subjectively "sensitivity difference," or the appreciation of "brightness difference." They claim that an appraisal of visual efficiency as well as the correction of refractive errors by the "brightness difference" method of the sensitometer is superior to the methods ordinarily used by the Snellen visual acuity charts. Claims are made with reference to the better control of accommodation monocularly and binocularly. With another device, the L. M. visibility control, it is said that greater refinement in the study of the elements of binocular vision and orthoptics is possible. While much of this sounds plausible, the whole treatment of the purely refractive, accommodative and binocular phases of vision does not have the sure scientific touch which characterizes the treatment of the other topics. One wonders where the authors got the information which leads them to say, "Although the subjective and objective techniques are often considered to be competitive methods for revealing and measuring refractive errors it would seem more appropriate to regard one as supplementary to the other." It is certainly the standard practice among ophthalmologists to regard the subjective and objective methods as supplementary and not as "competitive." More reliance is sometimes placed on one method than on the other, but not in a "competitive" sense.

In style, the work is somewhat verbose and repetitious. It could be considerably condensed and still retain all the essential facts and findings. Some of the diagrams and graphs are difficult to understand and will be especially irksome to physicians not thoroughly conversant with such methods.

But with all that there is a good deal of sound, informative material in the book for the practicing ophthalmologist. He will be impressed with the importance of the elements of brightness and brightness difference for good and comfortable seeing, as against mere light intensity. And with reference to light intensity, he will be impressed with the finding, though he may be vaguely aware of it, that in an actual experiment with a group of persons wearing glasses the corrected vision under low illumination was decidedly worse than the uncorrected vision under high illumination.

As the book is written by lighting engineers, overenthusiasm in the direction of overlighting may be expected. But the ophthalmologist

who wishes to render his patients a full ocular service will find in the book much useful information of a general nature and many helpful suggestions which will aid him in advising his patients relative to their seeing habits.

JOSEPH I. PASCAL.

Twenty-Third Annual Report of the Ophthalmic Hospitals Section for 1935. Ministry of Public Health, Egypt. Price, 12 piasters. Cairo: Government Press, 1937.

The annual report for 1935 shows that 5 additional ophthalmic branches were opened in the general hospitals in Egypt, the total number of ophthalmic units being 69. During the year there were 1,034,986 new patients and 32,623 inpatients, and 334,866 operations were performed. The percentage of patients who were found blind in one or both eyes was 6. Acute ophthalmia was responsible for 80 per cent of the blindness, and the gonococcus was still the predominating factor in the production of acute ophthalmia. Of 10,412 pupils examined in the school clinics, 99 per cent were found to be suffering from trachoma in its various stages; in 43 per cent the condition was serious.

A list of interesting conditions seen in the various units of the section is included. A report of the meeting of the Ophthalmological Society of Egypt is also given.

Of 128,138 operations performed, 1,920 were for senile cataract, 345 for soft cataract and 99,474 for trichiasis or entropion. The other operations, 26,400 in number, consisted of 6,402 excisions of the lacrimal sac; 1,295 trephinnings of the cornea and sclera, with iridectomy; 12 operations for detachment of the retina, and 24 tenotomies, with advancement. Pathologic reports show that 1,081 specimens were examined.

The causes of blindness in 65,971 cases were analyzed as follows: complications following conjunctivitis, 50,000 cases; atrophy of the optic nerve, 160, detachment of the retina, 126; retinitis pigmentosa, 43, monocular glaucoma, 3,440, and binocular glaucoma, 2,555.

ARNOLD KNAPP.

Elementi di biomicroscopia oculare. By G. Sala. Price, 50 liras. Pp. 206, with 88 illustrations. Bologna: Licinio Cappelli.

This is the first manual of biomicroscopy of the eye for the use of the practicing oculist that has appeared in Italian. The book is divided in two parts. In the first part the Zeiss slit lamp is described minutely, and the principles of the biomicroscopic examination are explained. The technic of this examination, with the different illuminations used, is well described, and useful advice is given for the interpretation of the images seen.

The second part deals with the description of the different parts of the eye, and the chapters are divided according to their anatomic precedence. Gonioscopy is mentioned briefly.

The book is plainly written and can easily be understood by the beginner. It is rich in illustrations, several of which were made by

the author; they help to give in a schematic form a clear picture of the progress made with this objective examination of the eye.

The bibliography is extensive, with more than 400 references to Italian and foreign authors. This book will be of great aid in making the use of the slit lamp popular, and it deserves to be on the bookshelf of every oculist.

V. LA ROCCA.

Neurology. By Roy R. Grinker, M.D. Second edition. Price, \$8.50. Pp. 999. Springfield, Ill.: Charles C. Thomas, Publisher, 1937.

The first edition of this textbook was reviewed in the ARCHIVES in November 1934 (vol. 12, p. 796). The second edition consists of a revision of the first, with the addition of new matter on the vegetative nervous system, on localization in the cerebral cortex and on electroencephalography. The chapter on infections has been rearranged, and new treatment for migraine, myasthenia gravis and myotonia congenita, material on vitamin deficiency in neuritis and new data on the relation of the cerebellum to the cortex have been added. These additions bring the book up to date and, together with the many admirable features which characterized the previous presentation of the subject-matter in the first edition, make it an unusually good textbook which should appeal to a steadily increasing group of readers.

ARNOLD KNAPP.

Anuario Médico Social de Cuba. Price, \$5. Pp. 684. Havana, Cuba: Ucar, García and Cía, 1937.

Revista cubana de oto-neuro-oftalmiatria, directed in Havana by Dr. Tomás R. Yanes, has made possible the edition of this work, which contains not only interesting data on the medical development of Cuba but the addresses of all the practicing physicians in this republic, with their names, their specialties, the year of their graduation, the universities from which they have graduated and other data.

The work is completely original. It is not a simple guide or medical directory; personal data are also given for each physician, which include several admirable and amusing caricatures.

This year book more than fulfils its purpose and will be found useful in many ways.

ARNOLD KNAPP.

External Diseases of the Eye. By D. T. Atkinson, M.D. Pp. 718, with 494 engravings. Second edition. Price, \$8. Philadelphia: Lea & Febiger, 1937.

The first edition of this book was reviewed by Dr. Sanford R. Gifford in the September 1934 issue of the ARCHIVES, page 461.

The second edition differs slightly from the first. The author has included a paragraph on conjunctival myiasis and one on iridencleisis for glaucoma. A page has been devoted to the discussion, in general terms, of orthoptic training. About one and a half pages cover the slit lamp appearance of the crystalline lens.

The illustrations still constitute the best feature of the book.

O. P. PERKINS.

Directory of Ophthalmologic Societies *

INTERNATIONAL

INTERNATIONAL ASSOCIATION FOR PREVENTION OF BLINDNESS

Honorary President: Prof. F. de Lapersonne, 217 Fauborg St. Honoré, Paris.
President: Dr. P. Bailliart, 66 Boulevard Saint-Michel, Paris, 6^e.
Secretary-General: Prof. M. Van Duyse, Université de Gand, Gand, Prov. Ostflandern, Belgium.
All correspondence should be addressed to the President, Dr. P. Bailliart.

INTERNATIONAL OPHTHALMOLOGIC CONGRESS

Secretary: Dr. E. Marx, Costzeedijk 316, Rotterdam, Netherlands.

INTERNATIONAL ORGANIZATION AGAINST TRACHOMA

President: Dr. A. F. MacCallan, 33 Welbeck St., London, W., England.

FOREIGN

BRITISH MEDICAL ASSOCIATION, SECTION ON OPHTHALMOLOGY

President: Dr. Stewart Duke-Elder, 59 Harley St., London, W. 1.
Secretary: Dr. Thomasina Belt, 13 Mitchell Ave., Jesmond, Newcastle-on-Tyne.
Place: Plymouth. Time: July 20-22, 1938.

CHINESE OPHTHALMOLOGICAL SOCIETY OF PEIPING

President: Dr. H. T. Pi, Peiping Union Medical College, Peiping.
Secretary: Dr. C. K. Lin, 180 Hsi-Lo-yen, Chienmeng, Peiping.
Place: Peiping Union Medical College, Peiping. Time: Last Friday of each month.

GERMAN OPHTHALMOLOGICAL SOCIETY

President: Prof. W. Lohlein, Berlin.
Secretary: Prof. E. Engelking, Heidelberg.
Place: Heidelberg. Time: July 4-6, 1938.

MIDLAND OPHTHALMOLOGICAL SOCIETY

President: Dr. T. E. Ashdown Carr, 34 Charnwood St., Derby, England.
Secretary: T. Harrison Butler, 81 Edmund St., Birmingham, England.
Place: Birmingham and Midland Eye Hospital.

OPHTHALMOLOGICAL SOCIETY OF EGYPT

President: Prof. Dr. Mohammed Mahfouz Bey, Government Hospital, Alexandria.
Secretary: Dr. Mohammed Khalil, 4 Baehler St., Cairo.

All correspondence should be addressed to the Secretary, Dr. Mohammed Khalil.

OPHTHALMOLOGICAL SOCIETY OF THE UNITED KINGDOM

President: Mr. Gordon M. Holmes, 9 Wimpole St., London, W. 1.
Secretary: Mr. H. B. Stallard, 35 Harley St., London, W. 1.

OPHTHALMOLOGY SOCIETY OF BOMBAY

President: Dr. D. D. Sathaye, 127 Girgaum Road, Bombay 4.
Secretary: Dr. H. D. Dastur, Dadar, Bombay 14.
Place: H. B. A. Free Ophthalmic Hospital, Parel, Bombay 12. Time: First Friday of every month.

* Secretaries of societies are requested to furnish the information necessary to make this list complete and to keep it up to date.

OXFORD OPHTHALMOLOGICAL CONGRESS

Master: Dr. C. G. Russ Wood, Hill House, Abberbury Rd., Iffley, Oxford, England.

Hon. Secretary-Treasurer: Dr. F. A. Anderson, 12 St. John's Hill, Shrewsbury, England.

Time: July 7-9, 1938.

PALESTINE OPHTHALMOLOGICAL SOCIETY

President: Dr. Arie Feigenbaum, Abyssinian Str. 15, Jerusalem.

Secretary: Dr. E. Sinai, Tel-Aviv.

POLISH OPHTHALMOLOGICAL SOCIETY

President: Dr. W. Kapuściński, 2 Waly Batorego, Poznań.

Secretary: Dr. J. Sobański, Lindley'a 4, Warsaw.

Place: Lindley'a 4, Warsaw.

ROYAL SOCIETY OF MEDICINE, SECTION OF OPHTHALMOLOGY

President: Dr. Ransom Pickard, 31 E. Southernhay, Exeter, England.

Secretary: Dr. A. Rugg-Gunn, 35 Harley St., London, W. 1.

SOCIÉTÉ FRANÇAISE D'OPHTALMOLOGIE

Secretary: Dr. René Onfray, 6 avenue de la Motte Picquet, Paris, 7è.

SOCIETY OF SWEDISH OPHTHALMOLOGISTS

President: Prof. K. G. Ploman, Stockholm, Sweden.

Secretary: Dr. K. O. Granström, Södermalmstorg 4 III tr., Stockholm, Sö., Sweden.

TEL-AVIV OPHTHALMOLOGICAL SOCIETY

President: Dr. D. Arie-Friedman, 96 Allenby Str., Tel-Aviv.

Secretary: Dr. Sadger Max, 9 Bialik Str., Tel-Aviv.

TSINAN OPHTHALMOLOGICAL SOCIETY

Chairman: Dr. Eugene Chan, Cheeloo University School of Medicine, Tsinan, Shantung.

Place: Cheeloo University School of Medicine. Time: Last Thursday of alternate months.

NATIONAL

AMERICAN MEDICAL ASSOCIATION, SCIENTIFIC ASSEMBLY, SECTION ON OPHTHALMOLOGY

Chairman: Dr. Parker Heath, 1553 Woodward Ave., Detroit.

Secretary: Dr. Derrick T. Vail Jr., 441 Vine St., Cincinnati.

Place: San Francisco. Time: June 13-17, 1938.

AMERICAN ACADEMY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY,
SECTION ON OPHTHALMOLOGY

President: Dr. Harry S. Gradle, 58 E. Washington St., Chicago.

Executive Secretary-Treasurer: Dr. William P. Wherry, 1500 Medical Arts Bldg., Omaha.

Place: Washington, D. C. Time: Oct. 9-14, 1938.

AMERICAN OPHTHALMOLOGICAL SOCIETY

President: Dr. Frederick H. Verhoeff, 243 Charles St., Boston.

Secretary-Treasurer: Dr. Eugene M. Blake, 303 Whitney Ave., New Haven, Conn.

Place: San Francisco. Time: June 9-11, 1938.

CANADIAN OPHTHALMOLOGICAL SOCIETY

President: Dr. W. Gordon M. Byers, 1458 Mountain St., Montreal.

Secretary-Treasurer: Dr. Alexander E. MacDonald, 421 Medical Arts Bldg., Toronto.

NATIONAL SOCIETY FOR THE PREVENTION OF BLINDNESS

President: Mr. William Fellowes Morgan, 50 W. 50th St., New York.
Secretary: Miss Regina E. Schneider, 50 W. 50th St., New York.

SECTIONAL

CENTRAL WISCONSIN SOCIETY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

President: Dr. L. C. Gardner, 11 N. Main St., Fond du Lac.
Secretary: Dr. G. L. McCormick, 626 S. Central Ave., Marshfield.
Place: Marshfield. Time: May 1938.

NEW ENGLAND OPHTHALMOLOGICAL SOCIETY

President: Dr. Edwin B. Goodall, 101 Bay State Rd., Boston.
Secretary-Treasurer: Dr. William P. Beetham, 5 Bay State Rd., Boston.
Place: Massachusetts Eye and Ear Infirmary, 243 Charles St., Boston. Time:
8 p. m., third Tuesday of each month from November to April, inclusive.

PACIFIC COAST OTO-OPHTHALMOLOGICAL SOCIETY

President: Dr. William D. Donohue, 1930 Wilshire Blvd., Los Angeles.
Secretary-Treasurer: Dr. C. Allen Dickey, 450 Sutter St., San Francisco.
Place: Victoria, B. C. Time: June 21-24, 1938.

PUGET SOUND ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. A. W. Howe, 740 St. Helens Ave., Tacoma, Wash.
Secretary-Treasurer: Dr. Purman Dorman, 1115 Terry Ave., Seattle.
Place: Seattle or Tacoma, Wash. Time: Third Tuesday of each month, except
June, July and August.

ROCK RIVER VALLEY EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. Frank W. Broderick, 501 Central Trust Bldg., Sterling, Ill.
Secretary-Treasurer: Dr. Thorsten E. Blomberg, 501-7th St., Rockford, Ill.
Place: Rockford, Ill., or Janesville or Beloit, Wis. Time: Third Tuesday of
each month.

SAGINAW VALLEY ACADEMY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

President: Dr. W. K. Slack, 308 Eddy Bldg., Saginaw, Mich.
Secretary-Treasurer: Dr. Andre Cortopassi, 703 Second National Bank Bldg.,
Saginaw, Mich.
Place: Saginaw or Bay City, Mich. Time: Second Tuesday of each month,
except July and August.

SIoux VALLEY EYE AND EAR ACADEMY

President: Dr. J. H. Judd, 107 S. 17th St., Omaha, Neb.
Secretary-Treasurer: Dr. J. C. Decker, 515 Frances Bldg., Sioux City, Iowa.

SOUTHERN MEDICAL ASSOCIATION, SECTION ON EYE, EAR, NOSE AND THROAT

Chairman: Dr. Grady E. Clay, Medical Arts Bldg., Atlanta, Ga.
Secretary: Dr. John R. Hume, 921 Canal St., New Orleans.

SOUTHWESTERN MICHIGAN TRILOGICAL SOCIETY

President: Dr. John Hunter McRae, 26 Sheldon Ave., S. E., Grand Rapids.
Secretary-Treasurer: Dr. Dewey R. Heetderks, 405 Medical Arts Bldg., Grand
Rapids.
Time: Third Thursday of alternate months.

WESTERN PENNSYLVANIA EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. C. M. Harris, Johnstown.
Secretary-Treasurer: Dr. C. Wearne Beals, Weber Bldg., DuBois.
Place: Johnstown. Time: May 19, 1938.

STATE

COLORADO OPHTHALMOLOGICAL SOCIETY

President: A presiding officer is selected for each meeting alternately until all members have served.

Secretary: Dr. John C. Long, 324 Metropolitan Bldg., Denver.

Place: Capitol Life Bldg., Denver. Time 7:30 p. m., third Saturday of the month, October to April, inclusive.

CONNECTICUT STATE MEDICAL SOCIETY, SECTION ON EYE, EAR,
NOSE AND THROAT

President: Dr. Charles T. Flynn, 41 Trumbull St., New Haven.

Secretary-Treasurer: Dr. Shirley H. Baron, 309 State St., New London.

Place: New London. Time: February 1938.

EYE, EAR, NOSE AND THROAT CLUB OF GEORGIA

President: Dr. John King, Thomasville.

Secretary-Treasurer: Dr. Mason Baird, 384 Peachtree St., Atlanta.

Place: Augusta. Time: May 1938.

INDIANA ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. C. W. Rutherford, 23 E. Ohio St., Indianapolis.

Secretary: Dr. Marlow W. Manion, 23 E. Ohio St., Indianapolis.

Place: Indianapolis. Time: First Wednesday in April.

IOWA ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. H. H. Lamb, American Bank Bldg., Davenport.

Secretary-Treasurer: Dr. B. M. Merkel, 604 Locust St., Des Moines.

Place: Davenport.

LOUISIANA-MISSISSIPPI OPHTHALMOLOGICAL AND OTOLARYNGOLOGICAL SOCIETY

President: Dr. C. A. McWilliams, G. and S. I. R. R. Bldg., Gulfport, Miss.

Secretary-Treasurer: Dr. Edley H. Jones, 1301 Washington St., Vicksburg, Miss.

Place: New Orleans. Time: Spring, 1938.

MICHIGAN STATE MEDICAL SOCIETY, SECTION OF OPHTHALMOLOGY
AND OTOLARYNGOLOGY

Chairman: Dr. F. N. Smith, Grand Rapids Clinic, Grand Rapids.

Secretary: Dr. Dewey R. Heetderks, 26 Sheldon Ave., S. E., Grand Rapids.

MINNESOTA ACADEMY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

President: Dr. Walter E. Camp, 1918 Medical Arts Bldg., Minneapolis.

Secretary-Treasurer: Dr. George E. McGeary, 920 Medical Arts Bldg., Minneapolis.

Time: Second Friday of each month from October to May.

MONTANA ACADEMY OF OTO-OPHTHALMOLOGY

President: Dr. Roy Grigg, Bozeman.

Secretary: Dr. A. W. Morse, 507 Phoenix Bldg., Butte.

NEW JERSEY STATE MEDICAL SOCIETY, SECTION ON OPHTHALMOLOGY,
OTOLOGY AND RHINOLARYNGOLOGY

Chairman: Dr. Oram Kline, 414 Cooper St., Camden.

Secretary: Dr. James S. Shipman, 542 Cooper St., Camden.

NEW YORK STATE MEDICAL SOCIETY, EYE, EAR, NOSE AND THROAT SECTION

Chairman: Dr. Marvin F. Jones, 121 E. 60th St., New York.

Secretary: Dr. Algernon B. Reese, 73 E. 71st St., New York.

Time: May 10, 1938.

NORTH CAROLINA EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. J. M. Lilly, 302 Old St., Fayetteville.
 Secretary-Treasurer: Dr. Frank C. Smith, 106 W. 7th St., Charlotte.
 Place: Charlotte. Time: October.

NORTH DAKOTA ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. H. Rosenberger, 221-5th St., Bismarck.
 Secretary-Treasurer: Dr. F. L. Wicks, 514-6th St., Valley City.
 Place: Bismarck. Time: May 1938.

OREGON ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. A. B. Dykman, Medical Dental Bldg., Portland.
 Secretary-Treasurer: Dr. Andrew J. Browning, 418 Mayer Bldg., Portland.
 Place: Good Samaritan Hospital, Portland. Time: Third Tuesday of each month.

RHODE ISLAND OPHTHALMOLOGICAL AND OTOLOGICAL SOCIETY

Acting President: Dr. N. Darrell Harvey, 112 Waterman St., Providence.
 Secretary-Treasurer: Dr. Linley C. Happ, 124 Waterman St., Providence.
 Place: Rhode Island Medical Society Library, Providence. Time: 8:30 p. m.,
 second Thursday in October, December, February and April.

SOUTH CAROLINA SOCIETY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

President: Dr. George Truluck, Orangeburg.
 Secretary: Dr. J. W. Jervey Jr., 101 Church St., Greenville.

TENNESSEE ACADEMY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

President: Dr. Kate Savage Zerfoss, 165-8th Ave., N., Nashville.
 Secretary-Treasurer: Dr. W. D. Stinson, 805 Medical Arts Bldg., Memphis.

TEXAS OPHTHALMOLOGICAL AND OTO-LARYNGOLOGICAL SOCIETY

President: Dr. T. E. Fuller, 100 W. Board St., Texarkana, Texas.
 Secretary: Dr. O. M. Marchman, 1719 Pacific Ave., Dallas.

UTAH OPHTHALMOLOGICAL SOCIETY

President: Dr. V. P. White, 143½ S. Main St., Salt Lake City.
 Secretary-Treasurer: Dr. E. B. Fairbanks, Boston Bldg., Salt Lake City.
 Time: Third Monday of each month.

VIRGINIA SOCIETY OF OTO-LARYNGOLOGY AND OPHTHALMOLOGY

President: Dr. M. H. Hood, 505 Washington St., Portsmouth.
 Secretary-Treasurer: Dr. Charles T. St. Clair, 418 Bland St., Bluefield, W. Va.

WEST VIRGINIA STATE MEDICAL ASSOCIATION, EYE, EAR, NOSE
 AND THROAT SECTION

President: Dr. George Traugh, 309 Cleveland Ave., Fairmont.
 Secretary: Dr. Welch England, 621½ Market St., Parkersburg.

LOCAL

ACADEMY OF MEDICINE OF NORTHERN NEW JERSEY, SECTION ON
 EYE, EAR, NOSE AND THROAT

President: Dr. James A. Fisher, 501 Grand Ave., Asbury Park.
 Secretary: Dr. William F. McKim, 488 Sanford Ave., Newark.
 Place: 91 Lincoln Park South, Newark. Time: 8:45 p. m., second Monday of
 each month, October to May.

AKRON ACADEMY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

President: Dr. L. E. Brown, Second National Bldg., Akron.
 Secretary-Treasurer: Dr. C. R. Anderson, 106 S. Main St., Akron.
 Time: First Monday in January, March, May and November.

ATLANTA EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. J. Mason Baird, Medical Arts Bldg., Atlanta, Ga.
 Secretary: Dr. Alton V. Hallum, 478 Peachtree St., Atlanta, Ga.
 Place: Academy of Medicine, 38 Prescott St. Time: Second Friday of each month from October to May.

BALTIMORE MEDICAL SOCIETY, SECTION ON OPHTHALMOLOGY

Chairman: Dr. Henry F. Graff, 513 N. Charles St., Baltimore.
 Secretary: Dr. Frank B. Walsh, Wilmer Institute, Johns Hopkins Hospital, Baltimore.
 Place: Medical and Chirurgical Faculty, 1211 Cathedral St. Time: 8:30 p. m., fourth Thursday of each month from October to May.

BROOKLYN OPHTHALMOLOGICAL SOCIETY

President: Dr. Walter V. Moore, 1 Nevins St., Brooklyn.
 Secretary-Treasurer: Dr. Mortimer A. Lasky, 1 Nevins St., Brooklyn.
 Place: Kings County Medical Society Bldg., 1313 Bedford Ave. Time: Third Thursday in February, April, May, October and December.

BUFFALO OPHTHALMOLOGIC CLUB

President: Dr. Ivan J. Koenig, 40 North St., Buffalo.
 Secretary-Treasurer: Dr. Meyer H. Riwchun, 367 Linwood Ave., Buffalo.
 Time: Second Thursday of each month.

CHATTANOOGA SOCIETY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

President: Each member, in alphabetical order.
 Secretary: Dr. A. H. Benz, 706 Medical Arts Bldg., Chattanooga.
 Place: Mountain City Club. Time: Second Thursday of each month from September to May.

CHICAGO OPHTHALMOLOGICAL SOCIETY

President: Dr. Georgiana Dvorak-Theobald, 715 Lake St., Oak Park.
 Secretary-Treasurer: Dr. Earle B. Fowler, 55 E. Washington St., Chicago.
 Place: Medinah Michigan Avenue Club, 505 N. Michigan Ave. Time: Third Monday of each month from October to May.

CINCINNATI OPHTHALMIC CLUB

Chairman: Each member, in rotation.
 Secretary-Treasurer: Dr. E. R. Thomas, 819 Carew Tower, Cincinnati.
 Place: Holmes Memorial Library, Cincinnati General Hospital. Time: 8:15 p. m., third Monday of each month except June, July and August.

CLEVELAND ACADEMY OF MEDICINE, SECTION OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

Chairman: Dr. Webb Chamberlin, 7405 Detroit Ave., Cleveland.
 Secretary: Dr. Walter H. Rieger, Hanna Bldg., Cleveland.
 Place: Winton Hotel. Time: Fourth Friday of each month.

CLEVELAND OPHTHALMOLOGICAL CLUB

Chairman: Dr. Paul Moore, Republic Bldg., Cleveland.
 Secretary: Dr. G. Leslie Miller, 14805 Detroit Ave., Cleveland.
 Time: Second Tuesday in October, December, February and April.

COLLEGE OF PHYSICIANS, PHILADELPHIA, SECTION ON OPHTHALMOLOGY

Chairman: Dr. Charles R. Heed, 1205 Spruce St., Philadelphia.
 Clerk: Dr. Alexander G. Fewell, 1924 Pine St., Philadelphia.
 Time: Third Thursday of every month from October to April, inclusive.

COLUMBUS OPHTHALMOLOGICAL AND OTO-LARYNGOLOGICAL SOCIETY

Chairman: Dr. C. E. Silbernagle, 247 E. State St., Columbus, Ohio.
 Secretary-Treasurer: Dr. D. M. Johnson, 327 E. State St., Columbus, Ohio.
 Place: Deshler Wallick Hotel. Time: 6 p. m., first Monday of each month.

CORPUS CHRISTI EYE, EAR, NOSE AND THROAT SOCIETY

Chairman: Dr. Edgar G. Mathis, 416 Chaparral St., Corpus Christi, Texas.
 Secretary: Dr. E. King Gill, 416 Chaparral St., Corpus Christi, Texas.
 Time: Second Thursday of each month from October to May.

DALLAS ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. Lester H. Quinn, 4105 Live Oak, Dallas, Texas.
 Secretary: Dr. J. Dudley Singleton, 1719 Pacific Ave., Dallas, Texas.
 Place: Dallas Athletic Club. Time: 6:30 p. m., first Tuesday of each month from October to June. The November, January and March meetings are devoted to clinical work.

DES MOINES ACADEMY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

President: Dr. E. G. Linn, 604 Locust St., Des Moines, Iowa.
 Secretary-Treasurer: Dr. Grace Doane, 614 Bankers Trust Bldg., Des Moines, Iowa.
 Time: 7:45 p. m., third Monday of every month from September to May.

DETROIT OPHTHALMOLOGICAL CLUB

Chairman: Members rotate alphabetically.
 Secretary: Dr. William Fowler, 1424 Maccabee Bldg., Detroit.
 Time: 6:30 p. m., first Wednesday of each month.

EASTERN NEW YORK EYE, EAR, NOSE AND THROAT ASSOCIATION

President: Dr. J. D. Carroll, 102-3d St., Troy, N. Y.
 Secretary-Treasurer: Dr. Joseph L. Holohan, 330 State St., Albany.
 Time: Third Wednesday in October, November, March, April, May and June.

FORT WORTH EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. Van D. Rathgeber, 1012 Medical Arts Bldg., Fort Worth, Texas.
 Secretary-Treasurer: Dr. Charles R. Lees, 306 W. Broadway, Fort Worth, Texas.
 Place: Medical Hall, Medical Arts Bldg. Time: 7:30 p. m., first Friday of each month except July and August.

GRAND RAPIDS EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. Dewey R. Heetderks, 405 Medical Arts Bldg., Grand Rapids, Mich.
 Secretary-Treasurer: Dr. Robert G. Laird, 116 E. Fulton St., Grand Rapids, Mich.
 Place: Various local hospitals. Time: Third Thursday of alternating months, September to May.

HOUSTON ACADEMY OF MEDICINE, EYE, EAR, NOSE AND THROAT SECTION

President: Dr. L. Allen, 1215 Walker Ave., Houston, Texas.
 Secretary: Dr. George C. Farrish, 1625 Main St., Houston, Texas.
 Place: Medical Arts Bldg., Harris County Medical Society Rooms. Time: 8 p. m., second Thursday of each month from September to June.

INDIANAPOLIS OPHTHALMOLOGICAL AND OTOLARYNGOLOGICAL SOCIETY

President: Dr. C. P. Clark, 24 E. Ohio St., Indianapolis.

Secretary: Dr. Kenneth L. Craft, 23 E. Ohio St., Indianapolis.

Place: University Club. Time: 6:30 p. m., second Thursday of each month from October to May.

KANSAS CITY SOCIETY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. O. S. Gilliland, 1103 Grand Ave., Kansas City, Mo.

Secretary: Dr. John S. Knight, 1103 Grand Ave., Kansas City, Mo.

Time: Third Thursday of each month from September to May. The November, January and March meetings are devoted to clinical work.

LONG BEACH EYE, EAR, NOSE AND THROAT SOCIETY

Chairman: Dr. F. C. Hertzog, 117 E. 8th St., Long Beach, Calif.

Secretary-Treasurer: Dr. Ben K. Parks, 619 Professional Bldg., Long Beach, Calif.

Place: Professional Bldg. Time: Last Wednesday of each month from October to May.

LOS ANGELES SOCIETY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. Clifford B. Walker, 427 W. 5th St., Los Angeles.

Secretary-Treasurer: Dr. John P. Lordan, 2007 Wilshire Blvd., Los Angeles.

Place: Los Angeles County Medical Association Bldg., 1925 Wilshire Blvd. Time: 6:30 p. m., fourth Monday of each month from September to May, inclusive.

LOUISVILLE EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. J. S. Bumgardner, Heyburn Bldg., Louisville, Ky.

Secretary-Treasurer: Dr. Max Bornstein, Heyburn Bldg., Louisville, Ky.

Place: Brown Hotel. Time: 6:30 p. m., second Thursday of each month from September to May, inclusive.

MEDICAL SOCIETY OF THE DISTRICT OF COLUMBIA, SECTION OF
OPHTHALMOLOGY AND OTOLARYNGOLOGY

Chairman: Dr. Earle Breeding, 1801 I St., N. W., Washington.

Secretary: Dr. Elmer Shepherd, 1606-20th St., N. W., Washington.

Place: 1718 M St., N. W. Time: 8 p. m., third Friday of each month from October to April, inclusive.

MEMPHIS SOCIETY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

Chairman: Each member, in alphabetical order.

Secretary: Dr. Sam H. Souders, Medical Arts Bldg., Memphis, Tenn.

Place: Eye Clinic of Memphis Eye, Ear, Nose and Throat Hospital. Time: 8 p. m., second Tuesday of each month.

MILWAUKEE OTO-OPHTHALMIC SOCIETY

President: Dr. John E. Mulsow, 231 W. Wisconsin Ave., Milwaukee.

Secretary-Treasurer: Dr. John B. Hitz, 411 E. Mason St., Milwaukee.

Place: University Club. Time: 6:30 p. m., second Tuesday of each month.

MINNEAPOLIS OPHTHALMOLOGICAL SOCIETY

Chairman: Each member, in alphabetical order.

Secretary: Dr. M. C. Pfunder, 645 Medical Arts Bldg., Minneapolis.

Place: Hennepin County Medical Society rooms. Time: 6:30 p. m., fourth Monday of each month, October to May, inclusive.

MONTGOMERY COUNTY MEDICAL SOCIETY

Chairman: Dr. P. H. Kilbourne, Fidelity Bldg., Dayton, Ohio.

Secretary-Treasurer: Dr. Maitland D. Place, 981 Reibold Bldg., Dayton, Ohio.

Place: Van Cleve Hotel. Time: 6:30 p. m., monthly, first Tuesday from October to June, inclusive.

MONTREAL OPHTHALMOLOGICAL SOCIETY

President: Dr. Stuart Ramsay, 1496 Mountain St., Montreal, Canada.
Secretary: Dr. J. Rosenbaum, 1396 St. Catherine St., W., Montreal, Canada.
Time: Second Thursday of October, December, February and April.

NASHVILLE ACADEMY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

Chairman: Dr. Guy Maness, 119-7th Ave., Nashville, Tenn.
Secretary-Treasurer: Dr. Andrew Hollabaugh, Doctors Bldg., Nashville, Tenn.
Place: St. Thomas Hospital. Time: 8 p. m., third Monday of each month from October to May.

NEW ORLEANS OPHTHALMOLOGICAL AND OTOLARYNGOLOGICAL SOCIETY

President: Dr. R. H. Fisher, Chess and Checker Club, New Orleans.
Secretary-Treasurer: Dr. H. F. Brewster, 837 Gravier St., New Orleans.
Place: Eye, Ear, Nose and Throat Hospital. Time: Third Thursday of each month from October to June.

NEW YORK ACADEMY OF MEDICINE, SECTION OF OPHTHALMOLOGY

Chairman: Dr. James W. White, 15 Park Ave., New York.
Secretary: Dr. Rudolf Aebli, 30 E. 40th St., New York.
Time: 8:30 p. m., third Monday of every month from October to May, inclusive.

NEW YORK SOCIETY FOR CLINICAL OPHTHALMOLOGY

President: Dr. Mark J. Schoenberg, 1160 Park Ave., New York.
Secretary: Dr. Jesse Stark, 45 Park Ave., New York.
Place: Squibb Hall, 745-5th Ave. Time: 7 p. m., first Monday of each month from October to May, inclusive.

OMAHA AND COUNCIL BLUFFS OPHTHALMOLOGICAL AND OTOLARYNGOLOGICAL SOCIETY

President: Dr. A. J. Young, 107 S. 17th St., Omaha.
Secretary-Treasurer: Dr. Delbert K. Judd, 1020 Medical Arts Bldg., Omaha.
Place: Omaha Club, 20th and Douglas Sts., Omaha. Time: 6 p. m., dinner; 7 p. m., program; third Wednesday of each month from October to May.

OPHTHALMOLOGICAL SOCIETY OF THE UNIVERSITY OF PITTSBURGH

President: Dr. W. W. Blair, 121 University Pl., Pittsburgh.
Secretary: Dr. George H. Shuman, 351-5th Ave., Pittsburgh.
Time: Second Monday in November, January, March and May.

PASSAIC-BERGEN OPHTHALMOLOGICAL CLUB

President: Dr. John S. Van Winkle, 297 Broadway, Paterson, N. J.
Secretary-Treasurer: Dr. T. A. Sanfacon, 340 Park Ave., Paterson, N. J.
Place: Paterson Eye and Ear Infirmary. Time: 9 p. m., last Friday of every month, except June, July and August.

PHILADELPHIA COUNTY MEDICAL SOCIETY, EYE SECTION

Chairman: Dr. Sidney L. Olsho, 235 S. 15th St., Philadelphia.
Secretary: Dr. Edmund B. Spaeth, 1930 Chestnut St., Philadelphia.
Time: First Thursday of each month from October to May.

PITTSBURGH OPHTHALMOLOGICAL SOCIETY

President: Dr. Glendon E. Curry, Westinghouse Bldg., Pittsburgh.
Secretary: Dr. George H. Shuman, 351-5th Ave., Pittsburgh.
Place: Pittsburgh Academy of Medicine Bldg. Time: Fourth Monday of each month, except June, July, August and September.

RICHMOND OPHTHALMOLOGICAL AND OTOLARYNGOLOGICAL SOCIETY

President: Dr. N. H. Turner, 200 E. Franklin St., Richmond, Va.
Secretary: Dr. Richard W. Vaughan, Medical Arts Bldg., Richmond, Va.
Place: Westmoreland Club. Time: 6 p. m., second Monday of each month from October to May.

ROCHESTER EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. R. E. Elliott, 78 S. Fitzhugh St., Rochester, N. Y.
 Secretary-Treasurer: Dr. Raphael Farber, 280 Monroe Ave., Rochester, N. Y.
 Place: Rochester Medical Association, 113 Prince St. Time: 8 p. m., third Monday of each month from October to May.

ST. LOUIS OPHTHALMIC SOCIETY

President: Dr. Lawrence T. Post, 508 N. Grand Blvd., St. Louis.
 Secretary: Dr. Leslie Charles Drews, 508 N. Grand Blvd., St. Louis.
 Place: Oscar Johnson Institute. Time: Clinical meeting 5:30 p. m., dinner and scientific meeting 6:30 p. m., fourth Friday of each month from October to April, inclusive, except December.

SAN ANTONIO OPHTHALMOLO-OTO-LARYNGOLOGICAL SOCIETY

President: Dr. Oscar H. Judkins, 414 Navarro St., San Antonio, Texas.
 Secretary-Treasurer: Dr. Wilfred E. Muldoon, 414 Navarro St., San Antonio, Texas.
 Place: Bexar County Medical Library. Time: 8 p. m., first Tuesday of each month from October to May.

SAN FRANCISCO COUNTY MEDICAL SOCIETY, SECTION ON EYE,
EAR, NOSE AND THROAT

Chairman: Dr. Russell Fletcher, 490 Post St., San Francisco.
 Secretary: Dr. Avery Morley Hicks, 490 Post St., San Francisco.
 Place: Society's Bldg., 2180 Washington St., San Francisco. Time: Fourth Tuesday of every month except May, June, July and December.

SHREVEPORT EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. J. A. Wilkinson, Medical Arts Bldg., Shreveport, La.
 Secretary-Treasurer: Dr. W. L. Atkins, 940 Margaret Pl., Shreveport, La.
 Place: Shreveport Charity Hospital. Time: 7:30 p. m., first Monday of every month except July, August and September.

SPOKANE ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. Raymond A. Lower, 407 Riverside Ave., Spokane, Wash.
 Secretary: Dr. Louis A. Parsell, Paulsen Medical and Dental Bldg., Spokane, Wash.
 Place: Paulsen Medical and Dental Library. Time: 8 p. m., fourth Tuesday of each month except June, July and August.

SYRACUSE EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. Gordon D. Hoople, 110 Medical Arts Bldg., Syracuse, N. Y.
 Secretary-Treasurer: Dr. I. Herbert Katz, 212 Medical Arts Bldg., Syracuse, N. Y.
 Place: University Club. Time: First Tuesday of each month except June, July and August.

TORONTO ACADEMY OF MEDICINE, SECTION OF OPHTHALMOLOGY

Chairman: A. Lloyd Morgan, Medical Arts Bldg., Toronto, Canada.
 Secretary: Dr. W. R. F. Luke, Medical Arts Bldg., Toronto, Canada.
 Place: Academy of Medicine, 13 Queen's Pk. Time: First Monday of each month, November to April.

WASHINGTON, D. C., OPHTHALMOLOGICAL SOCIETY

President: Dr. G. Victor Simpson, 1710 Rhode Island Ave., N. W., Washington, D. C.
 Secretary-Treasurer: Dr. Frank D. Costenbader, 1726 I St., Washington, D. C.
 Place: Episcopal Eye, Ear and Throat Hospital. Time: 8 p. m., first Monday in November, January, March and May.

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